George Duffield A.M.

In tali nunquam lassat venatio sylva.

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Knowledge for the People:

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OR, THE PLAIN

WHY AND BECAUSE.

FAMILIARIZING SUBJECTS OF USEFUL CURIOSITY AND AMUSING RESEARCH.

BY JOHN TIMBS,

Editor of 'Laconics:' 'Arcana of Science and Art,' &c.

"Its beginning is pleasure, its progress knowledge, and its objects truth and utility."—*Sir Humphry Davy.*

Zoological Series.

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KNOWLEDGE FOR THE PEOPLE:

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PLAIN WHY AND BECAUSE.

PART VII.—MECHANICS.

B

MECHANICS.

INTRODUCTORY.

Why are certain truths termed physical?

Because they explain the greater part of the phenomena of nature, the term physical being derived from the Greek word signifying *nature;* an appellation distinguishing them from *chemical* truths, which regard particular substances, and from *vital* truths, which have relation only to living bodies.—*Arnott.*

Why is an atom so called?

Because of its origin from a Greek word signifying *that which cannot be farther divided;* or, an exceedingly minute resisting particle.

Why is the term attraction used?

Because the atoms of which the visible universe is built up, whether separate, or already joined into masses, tend towards all other masses, with force proportioned to their proximity: as, when any body presses or falls towards the great mass of the earth, or when the tides on the earth rise towards the moon.

Why is the term repulsion used?

Because, under certain known circumstances, as of heat diffused among the particles, their mutual *attraction* is countervailed or resisted, and they tend to separate with force proportioned to their proximity: as, when heated water bursts into steam, or when gunpowder explodes.

Why is the term inertia used?

Because it denotes that the atoms, in regard to motion, have about them what may be figuratively called a *stubbornness*, tending always to keep them in their existing state, whatever it may be; in other words, that bodies neither acquire motion, nor lose motion, nor bend their course in motion, but in exact accordance to some force applied.

This, and the three preceding definitions, are derived from the Synopsis of Dr. Arnott's valuable *Elements of Physics*, Part I. third edit. 1828; the author pertinently observing, that "a person comprehending fully the import of these four words, *atom, attraction, repulsion, inertia*, may predict or anticipate correctly, very many of the facts and phenomena which the extended experience of a life can display to him."

Why are not men sensible of the rapid motion of the earth?

Because all things move at the same rate. Whatever *common* motions objects may have, it does not interfere with the effect of a force producing any new relative motion among them. All the motions seen on earth are really only slight differences among the common motions: as, in a fleet of sailing ships, the apparent changes of place among them are, in truth, only slight alterations of speed or direction in their individual courses.

Why does a spire or obelisk stand more securely on the earth, than a pillar stands on the bottom of a moving wagon?

Because the motion of the earth is uniform, and not that the earth is more at rest than the wagon. Were the present rotation of our globe to be arrested but for a moment, imperial London, with its thousand spires and turrets, would be swept from its valley towards the eastern ocean, just as loose snow is swept away by a gust of wind.—*Arnott.*

Why does a ball, let drop from the hand, fall with greater velocity the nearer it approaches the earth?

Because, owing to the inertia of matter, any force continuing to act on a mass which is free to obey it, produces in the mass a quickening or accelerated motion; for, as the motion given in the first instant, continues afterwards without any farther force, merely on account of the inertia, it follows that as much more motion is added during the second instant, and as much again during the third, and so on. A falling body, therefore, under the influence of attraction, is, as it were, a reservoir, receiving every instant fresh velocity and momentum (or quantity of motion). The height of a precipice, or the depth of a well, may be judged of with considerable accuracy, by marking the time required for a body to fall through the space. A body falls four times as far in two seconds as in one, although the velocity, at the end of two seconds, is only doubled.—*Arnott.*

A body falls by gravity precisely 16 1-16 feet in a second, and the velocity increases according to the squares of the time: *viz.*

In ¼″ (quarter of a second) a body falls		1	foot.
½″ (half a second)	ditto	4	
1 second	ditto	16	
2 ditto	ditto	64	
3 ditto	ditto	144	

The power of gravity at two miles distance from the earth, is four times less than at one mile; at three miles, nine times less; and so on. It goes on lessening, but is never destroyed.

Meteoric stones, falling from great heights, bury themselves deep in the earth, by the force of their gradually acquired velocity.

Why are we said to know of nothing which is absolutely at rest?

Because the earth is whirling round its axis, and

round the sun; the sun is moving round his axis, and round the centre of gravity of the solar system; and, doubtless, round some more remote centre in the great universe, carrying all his planets and comets about his path.

One of the grand laws of nature is, that all bodies persevere in their present state, whether of motion or rest, unless disturbed by some foreign power. Motion, therefore, once begun, would be continued for ever, were it to meet with no interruption from external causes, such as the power of gravity, the resistance of the medium, &c.

Dr. Arnott adduces several familiar illustrations of motions and forces. Thus, all falling and pressing bodies exhibit *attraction* in its simplest form. *Repulsion* is instanced in explosion, steam, the action of springs, &c. Explosion of gunpowder is repulsion among the particles when assuming the form of air. Steam, by the repulsion among its particles, moves the piston of the steam-engine. All elasticity, as seen in springs, collision, &c. belongs chiefly to repulsion. A spring is often, as it were, a reservoir of force, kept ready charged for a purpose; as when a gun-lock is cocked, a watch wound up, &c.

Why does a billiard ball stop when it strikes directly another ball of equal size, and the second ball proceed with the whole velocity which the first had?

Because the action which imparts the new motion is equal to the reaction which destroys the old. Although the transference of motion, in such a case, seems to be instantaneous, the change is really progressive, and is as follows: The approaching ball, at a certain point of time, has just given half of its motion to the other equal ball; and if both were of soft clay, they would then proceed together with half the original velocity; but, as they are elastic, the touching parts at the moment supposed, are compressed like a spring between the balls; and by their expanding,

and exerting force equally both ways, they double the velocity of the foremost ball, and destroy altogether the motion in the other.

Why is the uniformity of motion essential to rational conjecture or anticipation as to future events?

Because, it is by assuming, for instance, that the earth will continue to turn uniformly on its axis, that we speak of *to-morrow* and of *next week*, &c. and that we make all arrangements for future emergencies: and were the coming day or season, or year, to arrive sooner or later than such anticipation, it would throw such confusion into all our affairs that the world would soon be desolate.

To calculate futurities, then, (observes Dr. Arnott) or, to speak of past events, is merely to take some great uniform motion as a standard with which to compare all others; and then to say of the remote event, that it coincided, or will coincide, with some described state of the standard motion. The most obvious and best standards are the whirling of the earth about its axis, and its great revolution round the sun. The first is rendered very sensible to man by his alternately seeing and not seeing the sun, and it is called *a day;* the second is marked by the succession of the seasons, and it is called *a year*. The earth turns upon its axis about 365 times while it is performing one circuit round the sun, and thus it divides the year into so many smaller parts; and the day is divided into smaller parts, by the progress of the earth's whirling being so distinctly marked, in the constantly-varying directions of the sun, as viewed from any given spot on the face of the earth. When advancing civilisation made it of importance to man to be able to ascertain with precision the very instant of the earth's revolution, connected with any event, various contrivances were introduced for the purpose. Such have been sun-dials, where the shadow travels pro-

gressively round the divided circle; the uniform flux of water through a prepared opening; the flux of sand in a common hour-glass, &c. But the very triumphs of modern ingenuity and art are those astronomical clocks and watches, in which the counted equal vibrations of a pendulum, or balance-wheel, have detected periodical inequalities even in the motion of the earth itself, and have directed attention to unsuspected disturbing causes, important to be known.

Why, when a body is carried below the surface of the earth, does its weight become less?

Because the matter then above it is drawing it up, instead of down, as before. A descent of a few hundred feet makes a sensible difference, and at the centre of the earth, if man could reach it, he would find things to have no weight at all; and there would be neither up nor down, because bodies would be equally attracted in all directions.—*Arnott.*

Why is a horseman standing on the saddle enabled to leap over a garter extended over the horse, (the horse passing under the garter,) and to light upon the saddle at the opposite side?

Because, the exertion of the performer, in this case, is not that which he would use were he to leap from the ground over a garter at the same height. In the latter case, he would make an exertion to rise, and at the same time, to project his body forward. In the case, however, of the horseman, he merely makes that exertion which is necessary to rise directly upwards to a sufficient height to clear the garter. The motion which he has in common with the horse, compounded with the elevation acquired by his muscular power, accomplishes the leap.

Why does a walking stick help a man on a journey?

Because he pushes against the ground with the stick, which may be considered as compressing a spring

between the earth and the end of his stick, which spring is therefore pushing up as much as he pushes down; and if, at the time, he were balanced in the scales of a weighing beam, he would find that he weighed just as much less as he were pressing with his stick.

Why does a person wishing to leap over a ditch or chasm, make a run first?

Because the motion thereby acquired may help him over. A standing leap falls much short of a running one.

These facts also illustrate the same principle:—From a glass of water suddenly pushed forward on a table, the water is spilt or left behind, but if the glass be already in motion, as when carried by a person walking, and if it be then suddenly stopped by coming against an impediment, the water is thrown or spilt forward. Again, the actions of beating a coat or carpet with a cane to expel the dust; of shaking the snow from one's shoes by kicking against the door-post; of knocking a dusty book against a table, or shutting it violently.

Why is a man jumping from a carriage at speed, in great danger of falling, after his feet reach the ground?

Because his body has as much forward velocity, as if he had been running with the speed of the carriage; and unless he advance his feet as in running, he must as certainly be dashed to the ground, as a runner whose feet are suddenly arrested.—*Arnott.*

Why will the recoil of a fowling-piece hurt the shoulder, if the piece be not held close to it?

Because the piece recoils with as much motion or momentum in it as the ball has; but the momentum in the gun being diffused through a greater mass, the velocity is small, and easily checked.

Why does a sky-rocket ascend?

Because, after it is lighted, the lower part is always

producing a large quantity of aëriform fluid, which, in expanding, presses not only on the air below, but also on the rocket above, and thus lifts it. The ascent is aided also by the recoil of the rocket from the part of its substance, which is constantly being shot downwards.—*Arnott.*

Why does a hare, though much less fleet than a greyhound, often escape it?

Because the greyhound is, with the hare, a comparatively heavy body, moving at the same or greater speed in pursuit. The hare *doubles*, that is, suddenly changes the direction of her course, and turns back at an oblique angle with the direction in which she had been running. The greyhound, unable to resist the tendency of its body to persevere in the rapid motion it had acquired, is urged forward many yards before it is able to check its speed and return to the pursuit. Meanwhile the hare is gaining ground in the other direction, so that the animals are at a very considerable distance asunder when the pursuit is recommenced.

Why are a large and small ship sometimes seen sailing with the same velocity?

Because the surface of canvass or sail which they spread to catch the force of the wind, is proportioned to the difference of resistance which the water offers to the two.

Why are ships so often destroyed by running foul of each other at sea?

Because when two bodies moving in opposite directions meet, each body sustains as great a shock as if, being at rest, it had been struck by the other body with the united forces of the two. Thus, if two ships of 500 tons burden encounter each other, sailing at ten knots an hour, each sustains the shock, which, being at rest, it would receive from a vessel of 1000 tons burden, sailing ten knots an hour.

Why are carriages often overturned in quickly rounding corners?

Because the inertia carries the body of the vehicle in the former direction, while the wheels are suddenly pulled round by the horses into a new one. A loaded stage-coach running south, and suddenly turned to the east or west, strews its passengers on the south side of the road. Where a sharp turning in a carriage road is unavoidable, the outside of the bend should always be made higher than the inside, to prevent such accidents.

Why were the battering rams of the ancients such formidable engines of war?

Because they allowed the concentrated efforts of many hands, and a considerable duration of action, so as to give at last one great and sudden shock.

The action of gunpowder on bullets, although appearing so sudden, is still not an instantaneous, but a gradual, and therefore accelerating motion; and accordingly we find the effect to depend much on the length of the piece along which the force pursues the ball.—*Arnott.*

Why will a cannon or musket ball, shot quite horizontally, touch the ground of a level plane just as soon as another ball dropped at the same instant directly from the cannon's mouth?

Because the forward or projectile motion does not at all interfere with the action of gravity. This fact, observes Dr. Arnott, which most persons, before consideration, would be disposed to doubt, makes strikingly sensible the extraordinary speed of a cannon ball; *viz.* which has already carried it 600 or 800 feet before touching, during the half second that a ball dropped from the hand of a standing person requires to reach the earth. This fact also explains why, for a long range, the gun must always be pointed more or less upwards.—*Elements of Physics.*

The velocity of a musket ball is, on an average, 1,600 feet per second, and its range half a mile.

Why is this range only half a mile, whereas, by theory, it ought to be ten miles?

Because it is retarded by the resistance of the air.

In velocities exceeding 1,600 feet per second, the resistance of the air is greatly increased; hence the absurdity of giving balls too great an initial velocity. To give a bullet the velocity of 2000 feet per second, requires half as much more powder as to give it the velocity of 1,600 feet; yet after both have moved 400 feet, the difference between the velocity of each is reduced to 8 feet per second. A 24-pound ball, moving at the rate of 2000 feet per second, meets a resistance of 800 pounds.

If a body could be projected upwards with the velocity of 36,700 feet in a second, it would never return; and as it receded from the earth, its weight or gravity would diminish. At present, the greatest velocity with which we can project a body, does not exceed 2000 feet per second. A bullet rising a mile above the surface of the earth, loses 1-2000th part of its weight.—*Notes in Science.*

Lieut. Helwig, of Prussia, has invented a process for measuring the time occupied by a ball or bullet in passing through a certain space; by making the ball liberate the works of a time-keeper at the moment when it quits the mouth of the piece, and in making it also stop the time-keeper at the moment when it strikes an obstacle. Thus, he finds that a light body, of the same calibre with the bullet, moves, at the commencement, with much greater velocity than the latter; equal charges being used.

Steam cannon has not yet been found to realize all the formidable expectations which it had raised; but Mr. Perkins has estimated the projectile force of steam to be ten times greater than that of gunpowder, in throwing a ball to a given distance.

While on the subject of fire-arms, we may mention that an ingenious Frenchman proposes to fix a small mirror, 0.47 of an inch in the side, near the mouth-piece, so that the person using it shall see the reflexion of his own eye. In this way it is supposed that very exact aim may be taken; and the experiments made by various officers and sportsmen, are said to encourage the idea that this application may be useful.

Why will a bullet, fired against a door hanging freely on its hinges, perforate the same without agitating it?

Because the impression of the stroke is confined to one single spot, and sufficient time is not allowed for diffusing its action over the extent of the door. A pellet of clay, a bit of tallow, or even a small bag of water, discharged from a pistol, will produce the same effect.

Why is sea-sickness produced on shipboard?

Because man, strictly to maintain his perpendicularity, that is, to keep the centre of gravity always over the support of his body, requires standards of comparison, which he obtains chiefly by the perpendicularity or known position of things about him, as on land; but on shipboard, where the lines of the masts, windows, furniture, &c. are constantly changing, his standards of comparison are soon lost or disturbed. Hence, also, the reason why persons unaccustomed to the motion of a ship, often find relief by keeping their eyes directed to the fixed shore, where it is visible, or by lying on their backs, and shutting their eyes; and, on the other hand, the ill effects of looking over the side of the vessel at the restless waves of the sea.

Sea-sickness, observes Dr. Arnott, also depends partly on the irregular pressure of the bowels among themselves, and against the containing parts, when their inertia, or downward pressure, varies with the rising and falling of the ship.

Reasoning upon the last-mentioned facts, Mr. Pratt,

of New Bond-street, has constructed an elastic or swinging seat, couch, or bed, for preventing the uneasy motions of a ship or carriage; the frame of which is suspended on juribals or joints, turning at right angles to each other; and an elasticity is produced both in the seat or cushion, and in the swinging frames, by the use of spiral metal springs, in the form of an hour-glass. A still more simple preventive was illustrated by Sir Richard Phillips, on his crossing from Dover to Calais, a few years since. He caused an arm-chair to be placed on the deck of the vessel, and being seated in it, he began to raise himself up and down, as on horseback. The passengers laughed at his eccentricity, but before they reached Calais, many of them were sea-sick, whilst Sir Richard continued to enjoy his usual health and vigour. We mentioned this experiment whilst making the same passage in the Royal George steam-boat, about a fortnight since; but no person aboard made the trial of its efficacy, although more than half of the number were sea-sick.

An embrocation has lately been invented, and secured by patent, for preventing or alleviating sea-sickness; this preparation is to be rubbed over the lower end of the breast-bone, and under the left ribs; but we cannot add our own testimony of its efficacy.

Why cannot sure aim be taken with a stone in a sling?

Because the point from which it should depart, cannot be accurately determined.

Why is the pendulum a time-keeper?

Because the times of the vibrations are very nearly equal, whether it be moving much or little; that is to say, whether the arc described by it be large or small.

A common clock is merely a pendulum, with wheel-work attached to it, to record the number of the vibrations; and with a weight or spring, having force enough to counteract the retarding effects of friction and the

resistance of the air. The wheels show how many swings or beats of the pendulum have taken place, because at every beat, a tooth of the last wheel is allowed to pass. Now, if this wheel has sixty teeth, as is common, it will just turn round once for sixty beats of the pendulum, or seconds; and a hand fixed on its axis, projecting through the dial-plate, will be the second hand of the clock. The other wheels are so connected with this first, and the numbers of the teeth on them so proportioned, that one turns sixty times slower than the first, to fit its axis to carry a minute hand; and another, by moving twelve times slower still, is fitted to carry an hour-hand.—*Arnott.*

Why do clocks denote the progress of time?

Because they count the oscillations of a pendulum; and by that peculiar property of the pendulum, that one vibration commences exactly where the last terminates, no part of time is lost or gained in the juxtaposition (or putting together) of the units so counted, so that the precise fractional part of a day, can be ascertained, which each such unit measures.

The origin of the pendulum is traced to Galileo's observation of a hanging lamp in a church at Pisa continuing to vibrate long and with singular uniformity, after any accidental cause of disturbance. Hence he was led to investigate the laws of the phenomenon, and out of what, in some shape or other, had been before men's eyes from the beginning of the world, his powerful genius extracted the most important results.

The invention of pendulum clocks took place about the middle of the seventeenth century; and the honour of the discovery is disputed between Galileo and Huygens. Becher contends for Galileo, and states that one Trifler made the first pendulum clock at Florence, under the direction of Galileo Galilei, and that a model of it was sent to Holland. The Accademia del Cimento also expressly declared, that the application

of the pendulum to the movement of a clock, was first proposed by Galileo, and put in practice by his son, Vincenzo Galileo, in 1649. Huygens, however, contests the priority, and made a pendulum clock before 1658; and he insists, that if ever Galileo had entertained such an idea, he never brought it to perfection. Beckmann says the first pendulum clock made in England, was constructed in the year 1662, by one Tromantil, a Dutchman; but Grignon affirms that the first pendulum clock was made in England, by Robert Harris, in 1641, and erected in Inigo Jones's church of St. Paul, Covent-garden.

Why does the pendulum move faster in proportion as its journey is longer?

Because, in proportion as the arc described is more extended, the steeper are its beginning and ending; and the more rapidly, therefore, the pendulum falls down at first, sweeps along the intermediate space, and stops at last.—*Arnott.*

Why is it extremely difficult to ascertain the exact length of the pendulum?

Because of the various expansion of metals, respecting which no two pyrometers agree; the changeable nature of the atmosphere; the uncertainty as to the true level of the sea; the extreme difficulty of measuring accurately the distance between the point of suspension and the centre of oscillation, and even of finding that centre; also the variety of terrestrial attraction, from which cause the motions of the pendulum are also liable to variation, even in the same latitude. In pursuing his researches, Capt. Kater discovered that the motions of the pendulum are affected by the nature of the strata over which it vibrates.

Why does the force of gravity determine how long the pendulum shall be in falling to the bottom of its arc, and how long in rising?

Because the ball of the pendulum may be considered

as a body descending by its weight on a slope; a change in the force of gravity, therefore, would at once alter the rates of all the clocks on earth.—*Arnott.*

Why is the regulator of a watch merely a pin which bears against the balance-spring?

Because it slides backwards and forwards, so as to shorten or lengthen the part of the spring left free to bend, thus changing the degree of its stiffness; and, as the motion of the pendulum has relation to the force of gravity, so has the motion of the balance-wheel to the stiffness of the balance-spring.

Why do persons walking arm-in-arm, shake each other unless their steps correspond?

Because the centre of gravity in each body comes alternately over the right and over the left foot.

Why are certain metals malleable, or reducible into thin plates or leaves by hammering?

Because their atoms cohere equally in whatever relative situation they happen to be, and therefore yield to force, and shift about among each other, almost like the atoms of a fluid, without fracture or change of property.

Gold is remarkably malleable, for it may be reduced to leaves of the thinness of 282,000 to the inch. For gold-beaters the metal is first formed into rods, these are afterwards rolled or flattened into ribands, the riband is cut into portions, which are extended by hammering to great breadth and thinness, and which being again divided into portions, are hammered and extended to the thinness described.

Why are the steel chisels and tools used for cutting metals so frequently broken?

Because, requiring to be exceedingly hard, they proportionally lose, in regard to the extent of their elasticity. Cast iron, which is much harder than malleable or wrought iron, is very brittle, while soft iron and steel are the toughest things in nature.—*Arnott.*

Why does a smith, by hammering a piece of bar-iron, render it red hot?

Because he thereby compresses the metal. When air is violently compressed, it becomes so hot as to ignite cotton and other substances. An ingenious instrument for producing light for domestic uses has been constructed, consisting of a small cylinder, in which a solid piston moves air-tight: a little tinder, or dry sponge, is attached to the bottom of the piston, which is then violently forced into the cylinder: the air between the bottom of the cylinder and the piston becomes intensely compressed, and evolves so much heat as to light the tinder.—*Lardner.*

Why is the iron rim of a coach wheel heated before putting on?

Because the expansion of the metal occasioned by the heat, facilitates the operation of putting on the iron, while the contraction which follows, brings the joints of the wooden part together; and thus, binding the whole, gives great strength to the wheel.

Why does a bottle of fresh water, corked and let down 30 *or* 40 *feet into the sea, often come up again with the water saltish, although the cork be still in its place?*

Because the cork, when far down, is so squeezed as to allow the water to pass in or out by its sides, but on rising it, resumes its former size.

Why do bubbles rise on a cup of tea when a lump of sugar is dropped into it?

Because the sugar is porous, and the air which filled its pores then escapes to the surface of the tea, and the liquid takes its place.

Why are stalactites formed in the interior of caverns?

Because water percolates through their porous sides and roofs, and being impregnated with calcareous and other earths, assumes pendant forms.

Why is there an opening in the centre of the upper stone of a corn mill?

Because through this opening the grain is admitted

and kept turning round between the stones, and is always tending and travelling outwards, until it escapes as flour from the circumference.

Why does a horse in the circus lean to the centre?

Because, when the horse moves round with the performer standing on the saddle, both the horse and rider incline continually towards the centre of the ring, and the inclination increases with the velocity of the motion: by this inclination their weights counteract the effect of the centrifugal force.

Why does water remain in a vessel which is placed in a sling and made to describe a circle?

Because the water, by its inertia of straightness, or centrifugal (or centre-flying) force, tends more away from the centre of motion towards the bottom of the vessel, than towards the earth by gravity.

Why does a spinning top stand?

Because, while the top is perfectly upright, its point, being directly under its centre, supports it steadily, and although turning so rapidly, has no tendency to move from the place; but if the top incline at all, the side of the peg, instead of the very point, comes in contact with the floor, and the peg then becomes a little wheel or roller, advancing quickly, and, with its touching edge, describing a curve somewhat as a skaiter does, until it becomes directly under the body of the top as before. It thus appears that the very fact of the top inclining, causes the point to shift its place, and so that it cannot rest until it come again directly under the centre of the top.—*Arnott.*

Why is a rocking-stone so called?

Because it consists of an immense mass, loosened in some convulsion of nature, and with a slightly rounded base resting on a flat surface of rock below, which is so nearly balanced, that one individual can move or *rock* it. This arises from the rounded body being disturbed from its middle position, and its centre of gravity seeking to return.

Of these rocks, called Loggan or Laggan stones, there are several among the picturesque barriers of the British coast.

Dr. S. Hibbert has very recently described a natural rocking-stone of granite, near the village of Loubeyrat, in the province of Auvergne, France. This stone appears to have been an object of religious worship, for, on the top of it were two figures, a cross, and a pedestal. Under the figures the word *pardon* is traceable, and other letters which probably alluded to the number of days of pardon which the cross gave to the venerator. The natural phenomenon of the rocking-stone probably became an object of superstitious veneration to its neighbourhood, and the figures and cross were the adoring tributes of the natives. Dr. Hibbert, however, thinks that the particular use to which rocking-stones were applied will ever remain in obscurity: "as they are products of every country where loose detached rocks of a particular structure have been submitted to the operation of atmospheric agents, it is to be expected that the fables assigned to their origin would be regulated by the peculiar mythology of the people among whom they have become the object of notice and wonder."

Why have all shot manufactories lofty towers, as seen on the southern bank of the Thames?

Because, in the manufacturing of shot, the liquid metal is allowed to fall like rain from a great elevation, as through these towers, and the cohesive principle gives rotundity to grains of shot. In its descent, the drops become truly globular, and before they reach the end of their fall they are hardened by cooling, so that they retain their shape.

Why does a porter lean forward when carrying a load?

Because his position must be regulated by the centre of gravity of his body and the load taken together. If he bore the load on his back, the line of direc-

tion would pass beyond his heels, and he would fall backwards. To bring the centre of gravity over his feet he accordingly leans forward.—If a nurse carry a child in her arms, she leans back for a like reason.

Why does a young quadruped walk much sooner than a child?

Because a body is tottering in proportion to its great altitude and narrow base. Now, the child has this latter, and learns to walk but slowly, because of the difficulty, perhaps in ten or twelve months, while the young of quadrupeds, having a broad supporting base, are able to stand, and even to move about almost immediately: but it is the noble prerogative of man to be able to support his towering figure with great firmness, on a very narrow base, and under constant change of attitude.—*Arnott.*

Why are the "safety coaches" built with the wheels far apart, and the luggage-receptacles beneath the body?

Because they may have a broader base, and thus be less liable to overturn.

Why do builders use the plummet, or plumb line?

Because, when applied to a body, it is a visible indication of the line of its centre of gravity.

Why do certain structures remain secure, although they have lost their perpendicularity?

Because the line of their centre of gravity remains within the base. The famous tower of Pisa was built intentionally inclining, to frighten and surprise; it is 130 feet high, and overhangs its base 16 feet. At Bologna are two celebrated leaning towers, one of which, the Asinelli, is 350 feet high, and 3½ feet out of the perpendicular. The other, the Garisenda, is about 130 feet in height, and inclines 8 feet from the perpendicular. Montfaucon, the celebrated antiquary, attributes the leaning of these towers to the sinking of the earth. He says, it appears, upon examination, that when the Garisenda tower bowed, a great part of

it went to ruin, because the ground that the inclined side stood on was not so firm as the other, which may be said of all other towers that lean so; for "besides these two here mentioned, the tower for the bells of St. Mary Zobenica, at Venice, leans considerably to one side. So also at Ravenna, I took notice of another stooping tower, occasioned by the ground on that side giving way a little. In the way from Ferrara to Venice, where the soil is marshy, we see a structure of great antiquity leaning to one side. When the whole structure of the Garisenda stooped, much of it fell, as appears by the top."

The Monument, near London Bridge, inclines so much that timid people sometimes doubt its stability, and some years since its fall was a point of discussion. Salisbury and other of our cathedral spires or towers have lost something of their perpendicularity; Chesterfield, in Derbyshire, is proverbial for its zig-zag or wry spire.

The Monument is of the Doric order, and rises from the pavement to the height of 202 feet, containing within its shaft a spiral stair of black marble of 345 steps; the plinth is 21 feet square. It was begun in 1671, but was not completed till 1677; stone being scarce, and the restoration of London and its cathedral swallowing up the produce of the quarries. Mr. Elmes, in his Life of Sir Christopher Wren, the architect, tells us that the Monument was "at first used by the members of the Royal Society for astronomical experiments, but was abandoned on account of its *vibrations* being too great for the nicety required in their observations. This occasioned a report that it was unsafe; but its scientific construction may bid defiance to the attacks of all but earthquakes for centuries." The more recent fear of its instability was therefore only a revival of this alarm; which probably obtained some credence among weak persons, from its being erroneously attributed to Fellows of the Royal Society.

Why is it physically advantageous to turn out the toes?

Because the supporting base of a man consists of the feet and the space between them; and turning out the toes, without taking much from the length of the base, adds a good deal to the breadth.—*Arnott.*

Why do very fat people usually throw back their head and shoulders?

Because, by so doing, they keep the centre of gravity of the body over the base.

SIMPLE MACHINES.

Why have the "simple machines," as the lever, wheel and axle, plane, wedge, screw, and pulley, been long called the "mechanic powers?"

Because they were first used to raise great weights, or overcome great resistances. Hence the common error in supposing that they *generate* force, or have a sort of innate power for saving labour; whereas, neither simple machines nor mechanic powers save labour, in a strict sense of the phrase.

Why, then, are these machines advantageous?

Because they allow a small force to take its time to produce any requisite magnitude of effect. Thus, one man's effort, or any small power, which is always at command, by working proportionally longer, will answer the purpose of the sudden effort of many men, even of hundreds or thousands, whom it might be most inconvenient and expensive, or even impossible to bring together.

Why are there so many vain schemes for perpetual motions, and new mechanical engines of power?

Because the projectors do not understand the great truth, that no form or combination of machinery ever did or ever can increase, in the slighest degree, the quantity of power applied. Hence the futility of supposing that a lever, or great pendulum, or spring, or

heavy fly-wheel, &c. can ever exert more force than has passed into it from some source of motion.—*Arnott.*

THE LEVER.

Why is a beam or rod of any kind, resting at one part on a prop or axis, which becomes its centre of motion, a lever?

Because such a contrivance was first employed to lift (*levare*, Latin) weights.

The lever, in mechanics, compensates power by space, and what is lost in power is gained in time. If the lever be 17 feet long, and the pivot or fulcrum be a foot from one end, an ounce placed on the other end will balance a pound placed on the near end. If, instead of an ounce, we place upon the long end the short end of a second beam or lever, supported by a fulcrum one foot from it, and then place the long end of this second lever upon the short end of a third lever, whose fulcrum is one foot from it; and if we put upon the end of this third lever's long arm an ounce weight, that ounce will move upwards a pound on the second lever's long arm; and this moving upwards, will cause the short end to force downwards 16 pounds at the long end of the first lever, which will make the short end of the first lever move upwards, although 256 pounds be laid upon it. The same effect continuing, a pound on the long end of the third lever, will move up a ton and three-quarters at the short end of the first lever, so that the touch of a child's finger, will move as much as two horses can draw.—*Notes in Science.*

Why did Archimedes reasonably enough say, "Give me a lever long enough, and a prop strong enough, and with my own weight I will move the world?"

Because there is no limit to the difference of intensity in forces, which may be placed in opposition to each other by the lever, except the length and strength of the material of which the levers must be formed. But he would have required to move with the velocity

of a cannon-ball for millions of ages, to alter the position of the earth by the small part of an inch. This feat of Archimedes is, in mathematical truth, performed by every man who leaps from the ground, for he kicks the world away when he rises, and attracts it again when he falls back.—*Arnott.*

Why is a finger caught near the hinge of a shutting door so much injured?

Because the centre of action of the door moves through a space comparatively great, and acts with a great lever-advantage on a resistance placed near the fulcrum of the lever where there is little motion. Children pinching their fingers in this way, or in the hinge of the fire-tongs, where there is a similar action, wonder why the bite is so keen.

Why have pincers or forceps such extraordinary power?

Because they are double levers, of which the hinge is the common prop or fulcrum. Dr. Arnott thus illustrates the advantages of this machine:—In drawing a nail with steel nippers, we have a good example of the advantages of using a tool; 1. The nail is seized by teeth of steel, instead of by the soft fingers; 2. Instead of the griping force of the extreme fingers only, there is the force of the whole hand conveyed through the handles of the nippers; 3. The force is rendered, perhaps, six times more effective by the lever length of the handles; and, 4. By making the nippers, in drawing the nail, rest on one shoulder as a fulcrum, it acquires all the advantages of the lever or claw-hammer for the same purpose.

Why do lofty sails often cause open boats to upset?

Because the mast and sails set upon it are as a long lever, having the sails as the power, turning upon the centre of buoyancy of the vessel as the fulcrum, and lifting the balance or centre of gravity as the resistance.

as fast as the wheel descends, so as to maintain his position continually at the extremity of the horizontal diameter of the wheel.

The invention of the treadmill is, by some persons, said to have been derived from a squirrel in a cylindrical wire cage.

WHEEL CARRIAGES.

Why have wheel carriages been advantageously substituted for sledges?

Because the rubbing or friction, instead of being between an iron shoe and the stones and irregularities of the road, is between the axle and its bush, which have surfaces smoothed and fitted to each other, and well lubricated.

Why does the wheel aid the progress of a carriage?

Because, while the carriage moves forwards, perhaps 15 feet, by one revolution of its wheel, the rubbing part, viz. the axle, only passes over a few inches of the internal surface of its smooth greased bush. Again, the wheel surmounts any abrupt obstacle on the road, by the axle describing a gently rising slope or curve; and by rising as on an inclined plane, and giving to the drawing animal the relief which such a plane would bring.—*Arnott.*

Why are wheels usually made of a dished form, that is, inclining outwards?

Because they thus acquire astonishing strength, indeed that of the arch, as contrasted with the flat or upright wheel; the dished form is farther useful in this, that when the carriage is on an inclined road, and more of the weight consequently falls upon the wheel of the lower side, the inferior spokes of that wheel become nearly perpendicular, and therefore support the increased weight more safely. The disadvantage of these wheels, however, is, that an inclining wheel naturally describing a curved path, the

horses, in drawing straight forward, have to overcome this deviating tendency in all the wheels.—*Arnott.*

Why are axles made of steel, and the parts on which they bear of brass?

Because friction is universally diminished by letting the substances which are to rub each other be of different kinds. The swiftness of a skaiter, it may be observed, depends much on the dissimilarity between ice and steel.

Why are the fore-wheels of carriages smaller than the hind-wheels?

Because they facilitate the turning of the carriage. The advantage of the wheel is proportioned to the magnitude; the smaller wheel having to rise a steeper curve. It is not true, however, according to the popular prejudice, that the large hind-wheels of coaches and waggons help to push on the little wheels before them.—*Arnott.*

From these causes, continues the same ingenious writer, "the difference in performing the same journey of a mile by a sledge and a wheel carriage, is, that while the former rubs over every roughness in the road, and is jolted by every irregularity, the rubbing part of the latter, the axle, glides very slowly over about thirty yards of a smoothed oiled surface, in a gently waving line. It is ascertained that the resistance is thus reduced to 1-100th of what it is for a sledge."

Why do springs not only render carriages easy vehicles on rough roads, but much lessen the pull to the horses?

Because, where there is no spring, the whole load must rise with every rising of the road, and must sink with every depression, and the depression costs as much as the rising, because the wheel must be drawn up again from the bottom of it; but in a spring carriage, moving rapidly along, only the parts below the

springs are moved, in correspondence with the irregularities, while all above, by the inertia of the matter, have a soft and steady advance.—*Arnott.*

Again, springs of carriages convert all percussion into mere increase of pressure: that is to say, the collision of two hard bodies is changed by the interposition of one that is elastic, into a mere accession of weight. It is probable, that under certain modifications, springs may be applied with great advantage to the heaviest waggons.

In surmounting obstacles, a carriage with its load being lifted over, the springs allow the wheels to rise, while the weights suspended on them are scarcely moved from their horizontal level.

Why are "under-springs" so advantageous in very modern carriages?

Because they insulate from the effects of shocks, all the parts, excepting the wheels and axletrees themselves. When only the body of the carriage is on springs, the horses have still to rattle the heavy frame-work below it, over all irregularities.

Why, in descending a hilly road, is it common to lock or fix one of the wheels of a carriage?

Because, the friction is then increased, and there is less chance of a rapid descent; the horses having then to pull nearly as much as on a level road, with the wheel free.

We have noticed a very effectual mode of "locking" the hind wheels of carriages, on the continent, by screwing a bar transversely, against the outer rim of the wheels; by this means, the wheels may be either partially or wholly locked, according to a powerful screw, in the centre of the bar. This mode is adopted by the Paris diligences; we first noticed it in a Swiss *calèche*, of great strength. The bar is rather unsightly, but our excellence in the construction of wheel-carriages should not lead us always to look for ele-

gance, where convenience is a main point, as in a vehicle for travelling.

Why should a road up a very steep hill, be made to wind or zig-zag all the way?

Because, to reach a given height, the ease of the pull is greater, exactly as the road is made longer.

Why is it important to make roads as level as possible?

Because, a horse drawing on a road where there is a rise of one foot in twenty, is really lifting one twentieth of the load, as well as overcoming the friction, and other resistance of the carriage.—*Arnott.*

THE WEDGE.

Why are cutting instruments, knives, razors, the axe, &c. examples of the wedge?

Because at the same time that we pull them lengthwise, we press them directly forward, against the object. A saw, too, is a series of wedges.

Why does a razor, (if drawn lightly over the hand) dart into the flesh; whereas, if pressed against the hand with considerable force, it will not enter?

Because of the vibration of particles produced by the drawing action, which enables the razor to insinuate itself more easily. We witnessed an example, only a few days since, when a *bon vivant*, in a fit of mischievous ecstasy, seized a pointless table knife, and passed it very lightly down the back of his friend's coat. The injury was not immediately seen, but the cloth proved cut, from the collar to the waist; whereas, had the knife been heavily pressed against the cloth, the coat would have escaped injury, and the gay fellow the expense of his folly.

Why is the wedge so important an agent in the arts and manufactures?

Because it exerts enormous force through a very small space. Thus, it is resorted to for splitting masses

of timber, or stones. Ships are raised in docks, by wedges driven under their keels. The wedge is the principal agent in the oil-mill. The seeds, from which the oil is to be extracted, are introduced into hairbags, and placed between planes of hard-wood. Wedges inserted between the bags, are driven, by allowing heavy beams to fall on them. The pressure thus excited is so intense, that the seeds in the bags are formed into a mass nearly as solid as wood.—*Lardner.*

The details of an extensive oil mill near Garrat are as follow:—A magnificent water-wheel, of 30 feet, turns a main shaft, which gives motion to a pair of vertical stones, raises the driving-beams, and turns a band, which carries the seed in small buckets from the floor to the hopper. The shock on the entire nervous system, produced by the noise of the driving-beams as they fall on the wedges, is not to be described. The sense of hearing for the time is wholly destroyed, and the powers of voice and articulation are vainly exerted. The noise is oppressive, though a rebound, comparatively tuneful, takes place, till the wedge is driven home; but afterwards the blows fall dead, and produce a painful jar on the nerves, affecting the auditor for some hours with a sense of general lassitude.

THE SCREW.

Why does a screw enable a small force to produce such prodigious effects?

Because every turn of the screw carries it forward in a fixed nut, or draws a movable nut along upon it, by exactly the distance between two turns of its thread: this distance, therefore, is the space described by the resistance, while the force moves in the circumference of the circle described by the handle of the screw; and the disparity between these lengths or spaces is often as a hundred or more to one.—*Arnott.*

Why may the screw be called a winding wedge?

Because it has the same relation to a straight

wedge, that a road winding up a hill or tower has to a straight road of the same length and acclivity.

Why is the screw, in some respects, a disadvantageous contrivance?

Because it produces so much friction, as to consume a considerable part of the force used in working it.

Why do mathematical instrument makers mark divisions on their work with the screw?

Because it can easily be made with a hundred turns of its thread in the space of an inch, and at perfectly equal distances from each other. If we suppose such a screw to be pulling forward a plate of metal, or the edge of a circle, over which a sharp-pointed steel marker is placed, which moves up and down perpendicularly, the marker, if let down once for every turn of the screw, will make just as many lines on the plate; but, if made to mark at every hundredth or thousandth of a turn of the screw, which it will do with equal accuracy, it may draw a hundred thousand distinct lines in one inch.

Why may a printing press be said to do the work of fifty men?

Because a solitary workman, with his screw or other engine, can press a sheet of paper against types, so as to take off a clear impression; to do which without the press, the direct push of fifty men would be insufficient; and these fifty men would be idle and superfluous, except just at the instant of pressing, which recurs only now and then. This, and the two preceding illustrations, are almost literally from Dr. Arnott's works, in which the importance of having correct notions on the subject of the simple machines, or mechanical powers, is illustrated by many other familiar examples.

THE PULLEY.

Why is the pulley an advantageous machine?

Because, in such a construction, it is evident that

the weight (let it be supposed ten pounds) is equally supported by each end of the rope, and that a man holding up one end, only bears half of it, or five pounds; but to raise the weight one foot, he must draw up the two feet of rope; therefore, with the pulley, he lifts five pounds two feet, where he would have to lift ten pounds one foot without the pulley.

Why have fixed pullies no mechanical advantage?

Because the weight just moves as fast as the power; yet such pullies are of great use in changing the direction of forces. A sailor, without moving from the deck of his ship, by means of such a pulley, may hoist the sail or the signal flag to the top of the loftiest mast.

Why is the pulley on ship-board called a block?

Because of the block or wooden mass which surrounds the wheel or wheels of the pulley. Hence the machinery for making these pullies is called *block-machinery*. Of that at Portsmouth, invented by Brunel, there is a set of magnificent models in the possession of the Navy Board. They consist of eight separate machines, which work in succession, so as to begin and finish off a two-sheaved block four inches in length.

Mr. Faraday, in a lecture at the Royal Institution in 1829, stated generally, that the block-machinery of Portsmouth, by adjustments, could manufacture blocks of one hundred different sizes; could, with thirty men, make one hundred per hour; and, from the time of its completion in 1804-5, to that day, had required no repairs from Maudslay, the original manufacturer. The total cost was £46,000, and the saving per annum, in time of war, was £25,000, after allowing interest for capital, and paying the expense of all repairs.

Why is a chair or bucket, attached to one end of a rope which is carried over a fixed pulley, used as a fire-escape?

Because a person, by laying hold of the rope on the other side, may, at will, descend to a depth equal to

half of the entire length of the rope, by continually yielding rope on the one side, and depressing the bucket or chain by his weight on the other. In this case the pulley must be attached to some part of the building, or it is recommended that each chamber-floor of a dwelling-house should have a staple fixed near the exterior of a window, to which staple the pulley may be attached by a hook. This is, perhaps, the simplest fire-escape yet proposed, and we need scarcely add, the simpler the means the more likely is it to succeed in extreme danger.

FRICTION.

Why is the friction greater between pieces of the same substance, than between pieces of different substances, with dissimilar grains?

Because, it is supposed, of the roughnesses, or little projections in the former, mutually fitting each other, as the teeth of similar saws would.

"But for friction," observes Dr. Arnott, "men walking on the ground or pavement would always be as if walking on ice; and our rivers, that now flow so calmly, would all be frightful torrents."

Why does the friction of various woods against each other vary?

Because of their different degrees of hardness; the soft woods in general giving more resistance than the hard woods; thus, yellow deal affords the greatest, and red teak the least friction. Soft metals also produce greater friction, under similar circumstances, than those which are hard.—*G. Rennie.*

Why is the friction of surfaces, when first brought into contact, often greater than after their attrition has been continued a certain time?

Because the smoother the surfaces are the less will be the friction, and that process has a tendency to remove those minute asperities and projections on which the friction depends. But this has a limit, and after

a certain degree of attrition the friction ceases to decrease.

Why does smearing the surfaces with unctuous matter diminish the friction?

Because it fills up the cavities between the minute projections which produce the friction.

Why has plumbago, or black lead, been substituted for oil in clocks and chronometers?

Because, when mixed with spirit, it readily adheres to the surface of a steel pivot, as well as to the inside of the hole in which it runs, so that the rubbing surfaces are no longer one metal upon another, but plumbago upon plumbago. These surfaces, by their mutual action, speedily acquire a polish inferior only to that of the diamond, and then the retardation of the machine from friction is reduced almost to nothing, and wear and tear from this cause is totally prevented.

Why are jewelled holes injurious to the pivots of watches and chronometers?

Because, sooner or later, however perfect the polishing may be, the hard substance of the jewel grinds and cuts the steel pivot, and the metallic particles clog the oil.

Why is a peculiar metal requisite for pivot-holes?

Because it must preserve the oil in a fluid state, have little friction with the steel pivot, and be in a degree softer than the pivot, for it is of less consequence that the hole be worn than the pivot. Brass is objectionable, on account of its liability to rust, and gold is too soft for the purpose. Now, an alloy possessing the above requisites has lately been discovered by Mr. Bennett, watchmaker, of Holborn. It consists of pure gold, silver, copper, and palladium, and its small expense, compared with that of jewels, is not its least recommendation.

STRENGTH OF MATERIALS.

Why is a hollow tube of metal stronger than the same quantity of metal as a solid rod?

Because its substance, standing further from the centre, resists with a larger lever. Hence, pillars of cast-iron are generally made hollow, that they may have strength, with as little metal as possible. Masts and yards for ships have been made hollow, in accordance with the same principle.

Why does a plank bend and break more readily than a beam, and a beam resting on its edges, bear a greater weight than if resting on its side?

Because the resisting lever is smaller in proportion as the beam is thinner. Where a single beam cannot be found deep enough to have the strength required in any particular case, as for supporting the roof of a house, several beams are joined together, and in a great variety of ways, as is seen in house-rafters, &c. which, although consisting of three or more pieces, may be considered as one very broad beam, with those parts cut out which do not contribute much to the strength.—*Arnott.*

Why is a beam, when bent by its weight in the middle, very liable to break?

Because the destroying force acts by the long lever, reaching from the end of the beam to the centre, and the resisting force or strength acts only by the short lever, from the side to the centre; while only a little of the substance of the beam on the under side is allowed to resist at all. This last circumstance is so remarkable, that the scratch of a pin on the under side of a plank, resting as here supposed, will sometimes suffice to begin the fracture.—*Arnott.*

Why is a suspension bridge more economical than an ordinary, or insistent bridge?

Because a suspension-bridge varies its curve so as to adapt it to any variation or partial excess in its

load, in consequence of which, the strength of the chains may, with great precision, be adjusted to any required strain, and no more: while, in insistent bridges, the liability of the arch to a fatal derangement of its form by partial or excessive pressure, requires an enormous increase of weight and strength, beyond what is requisite for the mere support of its load, supposing it to be uniformly distributed.—*Ainger.*

Why is iron admirably adapted for the construction of suspension bridges?

Because the greater part of the weight of these bridges arises from the chains themselves, wherefore, the best material for the purpose, is that which has great tenacity with small weight; and iron is at the same time the most tenacious, and, excepting tin, the lightest of the common metals. A square inch of good iron requires about 25 tons to separate it,—and it will not be stretched or otherwise affected, with less than half that weight. Rope bridges, have, however, been introduced, with the advantages of economy and portability, into British India, where a rope-bridge, 160 feet in length, is so light and portable, that it has been several times set up and removed in a few hours.—*Ainger.*

We may here mention, that Mr. Bevan has found the strength or cohesion of cast-iron, to be upwards of 30,000 pounds to the square-inch, though much depends upon the mode of applying the force.

Why is iron best cemented by cast-iron?

Because pure iron, when surrounded by and in contact with cast-iron turnings, and heated, is carbonized very rapidly, so as to exhibit all the properties of steel.

Why is heated air now used in smelting iron?

Because it requires but three-fourths of the quantity of coal requisite, when cold air, that is, air not artificially heated, is employed for that purpose; while the produce of the furnace in iron, is at the same time

greatly increased. It is supposed, that this improvement will accomplish a saving in the cost of the iron, in Great Britain, to the amount of at least 200,000*l.* a-year.—*Jameson.*

Why are piles for bridge-building, driven by great weights being suddenly let fall on them?

Because the body of the workman being too weak, to give a forcible downward push directly, he employs a certain time in carrying a weight up to such an elevation above his work, that when let fall, its momentum may do what is required. Here the continued efforts of the man in lifting the weight, to a height of perhaps thirty feet, may be just sufficient to sink into the earth one inch; and the continuance has, therefore, balanced forces, which are to each other in intensity, as thirty feet to an inch.—*Arnott.*

Why does an ill-built bridge generally flatten in the arch?

Because the builder has not sufficiently attended to the effect of the horizontal thrust of the arch on its piers. Each arch is an engine of oblique force, pushing the pier away from it. In some instances, one arch of a bridge falling, has allowed the adjoining piers to be pushed down towards it, by the thrust, no longer balanced, of the arches beyond; and the whole structure has given way at once, like a child's bridge, built of cards.—*Arnott.*

The principle of bridge-building is beautifully illustrated by the small toy-models; the stones being represented by separate pieces of wood, which the juvenile architect is required to form into an arch, or arches. It could be wished that the above and such scientific toys were better appreciated in England. They seem only to suit the caprice of the moment. Thus, the Chinese, Indian, and other puzzles, were but the favourites of a year, and Dr. Brewster's splendid kaleidoscope was less understood, and more abused, than any modern discovery.

Why do the great domes of churches resemble simple arches?

Because they have strength on the same principle, being in general, strongly bound at the bottom, with chains and iron bars, to counteract the horizontal thrust of the superstructure; this binding, in truth, resembling a pier all round. St. Peter's at Rome, and St. Paul's in London, are fine examples; as is also the large fir roof of the Basilica of St. Paul's. At Rome, the trusses are double, and placed fifteen inches asunder, which gives it, probably, more stability than if they were strapped and bound into single masses.

Why is the Gothic or pointed arch so universally admired for its strength and beauty?

Because it bears the chief weight on its summit or key-stone. Bishop Warburton, in his *Divine Legation*, supposes the Gothic arch to have been taken from an avenue of trees. Hence the "high o'er arching groves," and "the verdant portico of woods," of Milton and Thomson; Cowper says,

> ———"The grove receives us next,
> Between the upright shafts of whose tall elms," &c.

In Betchworth Park, Surrey, is an avenue of gigantic elms: its length is 350 yards, resembling the *nave of a cathedral*; the trees form, on the outside, a vast screen or wall of verdure; within, the branches, meeting at a great height in the air from the opposite rows, form "Gothic arches," and exclude every ray of the meridian sun.

Why does the arched form bear pressure so admirably?

Because, by means of it, the force that would destroy is made to compress all the atoms or parts at once, and nearly in the same degree. The whole substance of the arch therefore resists, almost like that of a straight pillar under weight, and is nearly as strong.

The strength of the arched form is exemplified in the well-known experiment of bottles, containing only

air, and corked, being let down into the sea, and drawn up filled with water, and the cork driven in below the neck of the bottle. Thus, if the bottle have flat sides, and be square-bottomed, it will be broken by the pressure; but, if it be round, it will be more likely to resist the pressure, and have the cork forced in. The shape, in this case, is conducive to strength,—partaking of the qualities of an arch.

It is not known at what period the arch was invented, but it was comparatively in modern times. The hint was probably taken from nature; arched rocks being among the interesting wonders of the earth. At Lewis, in the Hebrides, is a stupendous specimen of curved gneiss, (a primitive rock, in which metals mostly abound) which has the bold symmetry of the Saxon arch. It is a matter of surprise, that, with so many specimens in nature, the arched form was not adopted earlier. The human skull is another specimen of the arched form; and the strength thus obtained, explains the unseeming impossibility of breaking an egg by pressing it endwise between our hands: again, what hard blows of the spoon or knife are often requisite to penetrate the shell. "The weakness of a similar substance, which has not the arched form, is seen in a scale from a piece of free-stone, which so readily crumbles between the fingers."

It is generally admitted, that the early Greeks were unacquainted with the principle of constructing the arch, and that neither the Indians nor Egyptians were acquainted with it. In Egypt, however, the monuments of which country are more ancient probably than any other on the face of the globe, the form of the Roman arch was well known, as is attested by remains of passages *cut out* in stone. Among the ruins of Thebes, sun-dried brick-buildings have been found to contain *constructed* arches, which may be referred to an age coeval with Thebes itself, as well as to any later period. In the oldest buildings of the Hairan, are round

and pointed arches, cut out and constructed; so that the arch may be carried back to the earliest period at which these fertile plains were first peopled by a race dwelling in houses; and this we know to have been as early as the time of Job, or even before, as, in his day, his sons and daughters feasted luxuriously in *houses*. It is not, however, to be necessarily inferred from this, that the Romans borrowed the form of the arch, or the principle of its construction, from the East, since these might both have existed in this quarter at an early period, and yet have been discovered in Italy at a much later date, without any knowledge of its existence elsewhere.—*Abridged from Buckingham's Travels.*

Why is the invention of architecture attributed to the Egyptians?

Because the Egyptian capitals are a complication of orders in one mass, which, if divided, would produce numerous hints for new ideas. Thus, from the *lotus*-leaved capitals, it will be acknowledged, that the *Doric* and *Corinthian* orders have been extracted. The *Ionic*, also, is believed to have originated in Egypt; from the remains of the small temple of Isis, in the island of Philæ. Isis, is the Io of the Greeks, from whom the name of Ionic was no doubt derived; and it is very probable, that he who introduced the order gave it that name, as having been taken from the temple of the goddess. Such is the hypothesis of Belzoni, respecting three of the five orders; the remaining two are thus explained:—the *Tuscan*, by inspection, and comparison of its component elements, will be found almost the same as the Doric, and is evidently derived from it; and the *Composite* is formed of the proportions and enrichments of the Corinthian order, and the angular volute of the Ionic.

Why did the Egyptians erect such stupendous monuments as the pyramids?

Because, it is conjectured, of the policy of the

Egyptian rulers, whose plan to prevent the ev... over-populousness, was, to accustom the lower orders... a spare diet, and employ them in the construction of huge edifices, destined for tombs, or the temples of religion. Hence, the pyramids and excavated temples, which still excite the wonder of the world, and prove what may be effected by the aid of the simplest machinery,—with time, numbers, and perseverance.—*Belzoni.*

Why do the more ancient Egyptian monuments exceed the later in design and execution?

Because, among the Egyptians, every thing advanced to a certain point of perfection;—there stopped, never to advance, but rather to recede.—*Belzoni.*

Why are light-houses built of a circular form?

Because, partaking of the properties of the arch, it best enables them to withstand the fury of tempests, from every quarter. The Eddystone light-house, built by Mr. Smeaton, the English engineer, is a splendid triumph of this principle.

Why were mirrors first used for reflecting light-houses?

Because of the following trivial circumstance.

At a meeting of a society of mathematicians, at Liverpool, one of the members proposed to lay a wager, that he would read a paragraph of a newspaper, at ten yards distance, with the light of a farthing candle. The wager was laid, and the proposer covered the inside of a wooden dish with pieces of looking-glass, fastened in with glazier's putty,—placed his reflector behind the candle, and won his wager. One of the company marked this experiment with a philosophic eye. This was Capt. Hutchinson, the Dock-master, with whom originated the Reflecting Light-houses, erected at Liverpool, in 1763.

The revolving lights, as at Calais, are an improvement upon this invention. Lieutenant Drummond's

ingenious application of ignited lime to the illumination of light-houses, a brilliant discovery of the present day, has been already noticed.*

Why is hempen-rope preferable to iron-chain for the scale of a weighing beam?

Because the rope resists a greater weight falling into the scale than is resisted by the chain, and is altogether stronger than the chain; the hemp yields by its elasticity, and continues its resistance through a considerable space and time,—and thus at last gradually overcomes the momentum; while the iron, by not yielding, either requires to be strong enough to stop the mass suddenly, or breaks.

Why are chain cables stronger than those of hemp or rope?

Because the chain, by its weight, hangs as a curve or inverted arch in the water, while the rope being nearly of the weight of water, is supported by it, and becomes almost a straight line from the anchor to the ship; and when a great wave dashes against the ship, the straight rope can only yield by the elasticity of its material, and, comparatively, therefore, a little way; but the bent chain will yield until it be drawn nearly straight, and by this greater latitude of yielding, and consequent length of resistance, it will stand a greater shock.—*Arnott.*

Why is British oak more durable than that of North America?

Because variable weather, as in Britain, conduces to firmness, whereas, the hot summers of North America impoverish its growth.

Why is steaming prejudicial to timber?

Because the heat and moisture together, always weaken that constituent principle of the timber, upon which its strength and durability in a great measure depend.

* See POPULAR CHEMISTRY, page 50

Why is steaming indispensable for ship-building?

Because the planks cannot be otherwise curved or twisted, as in the bends of the hull of the vessel.

To give an idea of the enormous quantity of timber necessary to construct a ship of war, we may observe, that 2,000 tons, or 3,000 loads, are computed to be required for a seventy-four. Now, reckoning fifty oaks to the acre, of 100 years standing, and the quantity in each tree at a load and a half, it would require forty acres of oak-forest to build one seventy-four; and the quantity increases in a great ratio, for the largest class of line-of-battle-ships. A first-rate man-of-war requires about 60,000 cubic feet of timber, and uses 180,000 pounds of rough hemp, in the cordage and sails for it. The average duration of these vast machines, when employed, is computed to be fourteen years. It is supposed, that all the oaks now in Scotland, would not build two ships of the line. In Sweden, all the oak belongs to the king, or the proprietors of estates can only dispose of it to government; so that, when not wanted for the navy, it is often left to decay, and indeed, is generally much neglected.

Why is teak wood superior to oak?

Because it is stronger and more buoyant. Its durability is more decided; and, unlike the oak, it may be put in use almost green from the forest, without danger of wet or dry rot. The oak contains an acid which corrodes and destroys iron; the teak, on the contrary, possesses an essential oil which preserves iron.

Why are beech and elm good timber for the lower keels of ships, and the piles of bridges and harbours?

Because both, when under water, are extremely durable; though neither stand the effects of the atmosphere.

Why is fir preferable to oak for common building?

Because it is lighter, far more elastic, more easily worked, straighter, and of much greater length. The

best that comes in the form of deals, is from Christiana and Frederickstadt, chiefly on account of the vast superiority of the saw-mills there.

Why was chestnut used in ancient roofs?

Because of its lightness and durability. The largest roof of the ancient construction is that of Westminster Hall, which is of chestnut. The support of every piece of timber is apparent; and the only strain which appears directly across the timber is on the boards and rafters between the great trusses; and it does not appear to be in the least decayed, although constructed four hundred and fifty years since.

COALS AND GUNPOWDER.

Why are coals so productive of grand mechanical effects?

Because of their great hidden powers, which we can at pleasure call into action. Thus, it is well known to modern engineers, that *there is virtue* in a bushel of coals, properly consumed, to raise seventy millions of pounds weight a foot high. This actually is the *average* effect of an engine at this moment working in Cornwall. The Menai Bridge, one of the most stupendous works of art that has been raised by man in modern ages, consists of a mass of iron not less than four millions of pounds in weight, suspended at a medium height of about 120 feet above the sea. The consumption of seven bushels of coal would suffice to raise it to the place where it hangs.

The great pyramid of Egypt is composed of granite. It is 700 feet in the side of its base, and 500 in perpendicular height, and stands on eleven acres of ground. Its weight is, therefore, 12,760 millions of pounds, at a medium height of 125 feet; consequently, it could be raised by the effort of about 630 chaldrons of coal, a quantity consumed in some foundries in a week.—*J. F. Herschel.*

Why is gunpowder another important source of mechanical power?

Because of the tremendous force which it exercises in certain operations, as blasting rocks, &c. in the progress of mechanical works. Thus, in the progress of cutting the Delaware Canal, four kegs of gunpowder, containing about 100lb. were, in 1829, used for a single blast, and had the effect of rending in pieces more than 400 cubic yards of rock.*

Yet it is only when we endeavour to confine gunpowder, that we get a full conception of the immense energy of that astonishing agent. In Count Rumford's experiments, twenty-eight grains of powder in a small cylindrical space *which was just filled*, tore asunder a piece of iron which would have resisted a strain of 400,000 pounds, applied at no greater mechanical disadvantage.

BALANCES.

Why are we enabled to determine the relative weight of a body, compared with the weight of another body, assumed as a standard, by means of the balance?

Because the balance consists of an inflexible rod or lever, called the beam, furnished with three axes; one, the fulcrum, or centre of motion, situated in the middle, upon which the beam turns, and the other two near the extremities, and at equal distances from the middle. These last are called the points of support, and serve to sustain the pairs or scales. These points and the fulcrum are in the same right line, and the centre of gravity of the whole should be a little below the fulcrum, when the position of the beam is horizontal. The arms of the lever being equal, it follows,

* By way of parallel with this effect, though produced by different means, we may mention that in 1825 there was opened in Cochin-China, a canal twenty-three miles long, eighty feet wide, and twelve feet deep. It was begun and finished in six weeks, although carried through large forests, and over extensive marshes. Twenty thousand men were at work upon it day and night; and it is said that seven thousand died of fatigue

that if equal weights be put into the scales, no effect will be produced on the position of the balance, and the beam will remain horizontal. If a small addition be made to the weight in one of the scales, the horizontality of the beams will be disturbed; and, after oscillating for some time, it will, on attaining a state of rest, form an angle with the horizon, the extent of which is a measure of the delicacy or sensibility of the balance.

Why should not the weights of a balance be touched by the hand?

Because that would not only oxydate the weight, (or cause it to rust) but by raising its temperature, it would appear lighter when placed in the scale-pan, than it should do, in consequence of the ascent of the heated air. For the large weights, a wooden fork or tongs should be employed; and for the smaller, a pair of forceps made of copper; this metal possessing sufficient elasticity to open the forceps on their being released from pressure, and yet not opposing a resistance sufficient to interfere with that delicacy of touch, which is desirable in such operations.—*Kater.*

Why does one weight alone serve to determine a great variety of others, by the steelyard?

Because the steelyard is a lever, having unequal arms, and by sliding the weight along the longer arm of the lever, we thus vary its distance from the fulcrum, taken in a reverse order; consequently, when a constant weight is used, and an equilibrium established, by sliding this weight on the longer arm of the lever, the relative weight of the substance weighed, to the constant weight, will be in the same proportion as the distance of the constant weight from the fulcrum is to the length of the shorter arm.

Why is the spring steelyard in very general use?

Because of its portability; as a spring that will ascertain weights from one pound to fifty, is contained

in a cylinder only 4 inches long, and ¾ inch diameter. To use this instrument, the substance to be weighed is suspended by a hook, the instrument being held by a ring passing through the rod at the other end. The spring then suffers a compression, proportionate to the weight, and the number of pounds is indicated by the division on the rod, which is cut by the top of the cylindrical tube.—*Kater.*

The dial weighing machine is a modification of the same principle, connected with hands on a dial or clock-face to denote the weight.

WATER.

Why do water-wheels vary in their construction?

Because of the different ways in which the mechanical force of the liquid is intended to be applied.

Why are certain of these wheels called overshot?

Because the water by which they are impelled descends from its level to a lower one; its weight during the descent (falling, as it were, *over* the wheel) causing the wheel to turn. That this may be possible, it is only necessary that there should be a sufficient supply of water at the superior level, and that there should be a means of carrying it off after its descent, so as to prevent by its accumulation, the equalisation of the two levels. Hence the necessity of flood-gates in a mill course. On the circumference of the wheel the weight of the water is made to act in its descent, in a direction as nearly as possible at the right angles to the spokes, or radii; this pressure, however, acting only at one side of the wheel; thus making the wheel revolve, and communicate motion to its axis; and this motion being transmitted by wheel-work, and other contrivances, to the machinery which it is required to work.

Why are other wheels called undershot?

Because the flat or float boards placed at equal distances on the rim, and projecting from it, in direc-

tions diverging from its centre, are intended to receive the impulse of the water as it passes *under* the wheel. The wheel is thereby caused to revolve in the direction of the stream, with a force depending on the quantity and velocity of the water, and the number, form, and position of the float-boards.

The *breast* wheel partakes of the nature of the overshot and undershot wheels; like the latter, it has float-boards; but, like the former, it is worked more by the weight of water than by its impulse.

The *power of water* on wheels may be thus illustrated. If 100 gallons per minute be equal to a certain power with one foot of fall, one gallon per minute will perform the same work with 100 feet of fall.*

Why is the hydrostatic or Bramah's press, another example of the mechanical agency of water?

Because water, in common with all fluids, possesses the power of transmitting pressure equally in every direction. In this instance, too, it is materially aided by the mechanical efficacy of the lever.

Pascal demonstrated this principle and its advantages, by fixing to the upper end of a cask set upright, a very long and narrow cylinder. In filling the barrel, and afterwards the cylinder, the simple addition of a pint or two of water, which the latter was capable of containing, produced the same effect as if the cask, preserving its diameter throughout, had its height increased by the whole length of the cylinder. Thus, the increase of weight of a pint or two of water, was sufficient to burst the bottom of the hogshead, by the immense augmentation of pressure it occasioned. Now, if we suppose the water removed from the cylinder of

* The mechanical force of running water is tremendous. During the great storm and flood in Scotland, in 1829, the river Don forced a mass of 400 or 500 tons of stones, many of 200 or 300 pounds weight, up an inclined plane, rising 6 feet in 8 or 10 yards. A stone of 3 or 4 tons, was likewise moved out of a deep pool of the river, 100 yards from its place.

narrow dimensions, and replaced by a solid of equivalent weight, such as a piston, it is evident that the pressure must remain everywhere the same. Again, if we suppose the weight of the piston to be multiplied by the power of a lever acting on its shaft, the pressure will be proportionally augmented, so as to produce on the bottom of the cask a pressure equivalent to an enormous weight, with the exertion of very little primitive force on the piston.—*Notes in Science.*

This property of liquids also enables us with great facility to transmit the motion and force of one machine to another, in cases where local circumstances preclude the possibility of instituting any ordinary mechanical connexion between the two machines. Thus, merely by means of water-pipes, the force of a machine may be transmitted to any distance, and over inequalities of ground, or through any other obstructions.

Why is the hydrostatic press more advantageous than that worked by a screw?

Because between solids and fluids there is little or no friction; and, accordingly, in the hydrostatic press no force is lost by friction, except what is necessary to overcome the friction of the pistons in the cylinders. The loss of power in the screw, by means of friction, has already been explained at page 32.

ANIMAL STRENGTH.

Why does the rate of steam carriages surpass the utmost stretch of animal power?

Because the machine by which they are propelled, unlike any animal, rolls along unimpeded in any degree by the speed of its own motion.

According to some experiments, recently made by Mr. Bevan, to determine the actual force of draught of carriages upon common roads, it appears that five horses will draw with equal ease the same load upon a good hard turnpike road, as thirty-three horses can

do upon loose sand. Or, if we assume the value of draught, upon a well-formed road in good condition, at 6*d.* per ton per mile, the equivalent price of draught will be upon hard turf, 7½*d.*; hard loam 9⅜*d.*; ordinary bye-road, 1*s.* 7*d.*; newly gravelled road, 2*s.* 2*d.*; loose sandy road, 3*s.* 1*d.*—*Philos. Mag.*

The power of some dogs is very extraordinary. Nine Esquimaux dogs, belonging to Captain Lyon, dragged 1611 pounds one mile (1760 yards) in nine minutes, and worked in this manner for seven or eight hours a day.

Why is it so disadvantageous to propel boats on canals by means of horses?

Because the expenditure of animal strength takes place in a far greater proportion than the increase of speed. Thus, if a horse of a certain strength is barely able to transport a given load ten miles a day for a continuance, two horses of the same strength will be altogether insufficient to transport the same load twenty miles a day. To accomplish that a greater number of similar horses would be requisite. If a still greater speed be attempted, the number of horses necessary to accomplish it would be increased in a prodigiously rapid proportion. This will be evident, if the extreme case be considered, viz., that there is a limit of speed which the horse, under no circumstances, can exceed. In an ordinary canal one horse with a boat will be sufficient for every thirty tons.

Why is a man better enabled than a horse to carry a weight up a steep hill?

Because the peculiar disposition of the limbs of a man, renders him well fitted for this species of labour; whereas it is the worst method in which a horse can be employed. It has been observed that three men climbing a hill, loaded with 100lbs. each, will ascend with greater speed than one horse carrying 300lbs.

The average value of human strength, considered

as a mechanical agent, has been variously estimated. Desaguliers considers that a man can raise the weight of 550lbs. ten feet high in a minute, and continue to do so for six hours. Smeaton, however, thinks that six good English labourers will be required to raise 21,141 solid feet of sea-water to the height of four feet in four hours. In this case, they will raise very little more than six cubic feet of fresh water each, ten feet high in a minute. The labourers whom Smeaton supposes to execute this work he considers to be equal to twice the number of ordinary men. It would, therefore, perhaps, be a fair average value of a man's work to estimate it, for a continuance, at half a hogshead of water raised through ten feet in a minute.

The efforts of men differ with the manner in which these efforts are employed. It has been shown by Mr. R. Buchanan, that the same quantities of human labour employed in working a pump, turning a wheel, ringing a bell, and rowing a boat, are as the numbers 100, 167, 227, and 248. The most advantageous manner of applying human strength is in the art of rowing.—The strength of an ordinary man walking in an *horizontal* direction, and with his body inclining forward, is, however, only equal to 27lb., and it is known by experience, that a horse can draw *horizontally* as much as seven men.

Why is the power of a steam-engine expressed in horse power?

Because this mode was introduced when steam engines first began to supersede horse mills, when the manufacturer naturally inquired how many horses a steam-engine would dispense with. Hence the expression is more practical than scientific.

The power of a horse is understood to be that which will elevate a weight of 33,000* pounds, the height of

* Another estimate reduces this to only 22,000 pounds, raised one foot high in a minute, equivalent to 100 pounds in two miles and a half per hour.

one foot in a minute of time, equal to about 90 pounds at the rate of four miles an hour. This is a force greater than that exerted by a common cart horse, which is not estimated at more than 70 pounds: that is to say, that a horse harnessed to a cart, weighing, with its load, forty cwt. or two tons, and drawing on a level road at the rate of four miles an hour, makes use of the same force, as if his traces, instead of being fastened to a cart, were passed over a pulley, and lifted perpendicularly a weight of 70 pounds.

A steam-engine consumes about 20 feet of steam per minute for every horse-power.—*Notes in Science.*

RAILWAYS.

Why are railways more economical than ordinary roads?

Because, to drag a loaded waggon up one inconsiderable hill, costs more force than to send it thirty or forty miles along a level railway; and the conclusion follows, that although the original expense of forming the level line might materially exceed that of making an ordinary road, still, in situations of great traffic, the difference would soon be paid by the savings; and when once paid, the savings would be as profit ever after.—*Arnott.*

By way of illustrating the great economy of machinery, we may observe, that in Sedjah, (where the Arabs obtain fine millstones) "their unskilfulness and want of proper implements adapted to their labour, with the expense of carriage from the quarry to the place of sale, each stone requiring a single camel, (wheel carriages and good roads being entirely unknown) occasion an advance above the prime cost at which they might be hewn in England, of at least 500 per cent, each pair of stones costing from ten to twenty pounds sterling."—*Buckingham's Travels.*

Why has a suspension railway been represented as more advantageous than a ground railroad?

Because the former takes a straightforward point from one town to another, without regard to the surface of the country over which it has to go, whether rising or falling, a perfect level being obtained by varying the heights of the pillars or piers which support the railway; while its height above the ground allows agriculture and commerce to go on under it without interruption. The cost of a suspension railway has been estimated at £1,400 per mile, which is about two-thirds less than the average expense of a ground railroad. Models of a suspension railway, and carriages adapted to it, were recently exhibited in London, by Mr. Maxwell Dick, their inventor.

Why is wrought iron preferable to cast iron for railways?

Because by wrought iron rails we reduce the number of joints; the difficulty of making the rails perfectly even at the joints, has also contributed much towards the introduction of wrought iron.

Edge railways were first made of wood, near Newcastle; these were next covered with plates of wrought iron in the parts most likely to wear. Cast iron was subsequently introduced there and elsewhere; and wrought iron is now being very generally substituted for the cast.

Why has it been proposed to transfer the power of fixed and cheap first movers to locomotive carriages, &c. travelling on common turnpike roads?

Because the power of a steam-engine, moving with the locomotive carriage, is very expensive when compared to an equal power obtained by a large ordinary fixed engine, a wind or water mill, or other common first mover. Mr. Fordham, the originator of this plan, proposes to condense air into cylinders, and then, to use this condensed air as the motive force.

Why has the application of steam to land carriages been so long a favourite project with mechanicians?

Because the transition from the one element to the other appears, at first view, to be so simple and easy: the same mechanical process which turns the paddle wheels of a vessel in the water, would seem quite adequate to impart a similar motion to the wheels of a carriage on land. So early as the year 1769, Mr. Watt mentions the practicability of applying it to domestic improvement, though it does not appear that Watt gave motion to a carriage. Symington, who claims the original invention of the steam-boat, had previously contrived a similar application for the impelling of carriages; and actually exhibited, in the year 1787, in Edinburgh, the first model of a steam-carriage that was perhaps ever seen. Hence we may conclude that the repeated failures in the plan have not been occasioned so much by the want of practical skill, as by some radical difficulty which had not been sufficiently adverted to.

The steepest inclined planes which, as far as we are aware, locomotive engines have attempted to surmount, are those on the Bolton and Leigh railway, in Lancashire. One of these planes is a mile and a half long, and rises one yard in thirty. Up the former of these the *Sans Pareil* engine ascended, drawing after her her tender carriage with coal and water, two waggons loaded with iron, and a carriage with passengers, making a gross weight drawn, of about fifteen tons; with which she moved at the rate of nine miles per hour. Up the steepest plane (rising 1 yard in 30) she drew her tender, and one carriage with passengers, the gross weight being about four tons fifteen cwt., with which she ascended at a speed of from nine to eleven miles per hour; each of these performances being equal to about sixty-five tons drawn on a level. —*Note to Quarterly Review.*

Why was the difficulty just adverted to greater in the land carriage than in the boat?

Because of the resistance to the progress of the

carriage by the inequalities and other obstructions on the roads. It is not here as in navigation, where the most enormous weights are buoyed up by the liquid element, without increasing, in the same degree, the resistance to the vessel. Every additional load to a land carriage creates an additional resistance, arising from inertia, friction, and other such impediments, exactly in proportion to its weight.—*Quarterly Review.*

Why does the progress of locomotive engines on railroads appear so extraordinary?

Because we compare their moving power and resistance with other moving powers and resistances to which our minds have been familiar. To the power of a steam-engine, in fact, there is no practical limit; the size of the machine and the strength of the materials excepted. This is compared with agents to whose powers nature has not only imposed a limit, but a narrow one. The strength of animals, as just shown, is circumscribed, and their power of speed still more so.

Why are railways usually laid down in double lines?

Because carriages, moving in opposite directions, may pass each other without interfering. In the same manner, a third or fourth, or more lines, may be laid down, if necessary; and, between them are communications, at intervals, by which any carriage overtaking another in the same track, may turn aside to one of the adjacent lines, and pass it, without stopping either.

The Chevalier Baader, of Munich, has contrived a plan for this purpose, so that no siding planes nor turning plates are necessary; and turning can be performed almost as quickly and as easily as upon a common turnpike road. He has also constructed waggons, so that upon a dead level, the power of one horse is sufficient to draw with ease, and at a good pace, a load of from twelve to fourteen tons, when

divided amongst several carriages linked together. The Chevalier also states that he has discovered a new principle, by which the power and motion of stationary steam-engines, and other machines, established at considerable distances apart, along the railroads, and working without interruption, can be imparted to any number of loaded carriages passing upon the railway, from one steam-engine or machine to another, without the employment of drag-ropes or chains, or, indeed, of any intermediate apparatus; and yet with any reasonable degree of velocity. These extraordinary statements are made in the *Franklin Journal*, 1830.

Why are the resistances which occur on a railway rather diminished than increased by velocity of motion?

Because the quicker we move along, there is the less time for the retarding force to operate; by increasing the rapidity, we escape, in some degree, from its influence, and may really be urged forward with a smaller amount of force, provided the machinery be adapted to so quick a rate of motion.—*Quarterly Review.*

Why has a tubular boiler, or one composed of welded iron pipes, been adopted by Mr. Gurney, in his steam carriage?

Because, even from the bursting of such a boiler, there is not the most distant chance of mischief to the passengers. Instead of being, as in ordinary cases, a large vessel closed on all sides, with the exception of the valves and steam conductors, which a high pressure or accidental defect may burst, Mr. Gurney's boiler consists of a horse-shoe of pipes, and the space between them is the furnace; the whole being enclosed with sheet-iron. The only possible accident would therefore be the bursting of one of these pipes, and a temporary diminution of the steam power, according to the proportion the pipe bears to the whole boiler.

Why were two steam cylinders introduced instead of one, in the early locomotive engines?

Because, by acting at different parts of the wheels, they produced a much more regular motion than formerly, and rendered unnecessary a fly-wheel, which had hitherto been used.

Why were the early engines so injurious to the railway?

Because of their enormous weight, amounting to six or eight tons, exclusive of the tender for water and fuel. The Rocket, lately constructed by Messrs. Stephenson and Co. of Newcastle-upon Tyne, weights only four tons five cwt.; and the Novelty, by Messrs. Braithwaite and Ericson, weighed but two tons fifteen cwt.

Why is a low chimney desirable, as in the Novelty engine?

Because it enables the proprietors of the railway to reduce the height of all the bridges under which the engines must pass, in crossing any of the public as well as private roads. It will admit of a deduction of seven or eight feet from the height of the masonwork in every such bridge. What a saving, then, must this produce in the original cost of a railway, through a cultivated country, where these bridges must frequently occur.—*Quarterly Review.*

Why is it no longer necessary to lay out railways on a perfect level?

Because engines have already been made to draw carriages up inclined planes rising one yard in thirty, and one yard in seventy-two, at the rate of from nine to eleven miles an hour. Hence we are enabled to vary the levels, and adapt them to the undulating nature of the country through which the line passes.

Why are steam carriages for the conveyance of goods, expected to improve the internal intercourse of this country in a very important degree?

Because it is calculated that the carriage of goods, which is now about 9*d.* or 10*d.* a ton per mile, by land, would thus be reduced to 2*d.*; and, in point of

speed, one day would do the work of four. The heaviest commodities, such as corn, potatoes, coals, &c. would bear the expense of carriage for a hundred miles; the expense of living in great towns would be reduced, and the price of raw produce would rise in remote parts of the country.

Again, "with so great a facility and celerity of communication, the provincial towns of an empire would become so many suburbs of the metropolis, or rather, the effect would be similar to that of collecting the whole inhabitants into one city."—*Scotsman Newspaper.*

Another great source of revenue and of trade, from this improved mode of intercourse, (observes the *Quarterly Review*) would arise from the conveyance of those fine goods, parcels of value, and all light articles, where speed and certainty are required; and which are now sent, at great expense, by coaches. In this manner the seats of the various finer and lighter manufactures would be brought almost into immediate contact with the great markets for their disposal. A merchant in London, on receiving any particular order, might send either to Nottingham, to Birmingham, or to Sheffield, or even to Manchester or Leeds, and have the goods in his shop the next or following day, at an expense not exceeding 1*s.* 6*d.* or 2*s.*

Lastly, the rapid circulation of intelligence. The mails might travel safely at 25 miles an hour, and letters be conveyed between London and Edinburgh, a distance of 400 miles, in 18 hours; so that an event happening in London, would be known in Edinburgh the same day.

As an example of the difficulties of internal navigation, before the introduction of steam for that purpose, it may be mentioned that, on the great river Mississippi, which flows at the rate of five or six miles an hour, it was the practice of the boatmen, who brought down the produce of the interior to New Orleans, to

break up their boats, sell the timber, and afterwards return home slowly by land; and a voyage up the river from New Orleans to Pittsburgh, a distance of about two thousand miles, could hardly be accomplished, with the most laborious efforts, within a period of four months. This voyage is now made by steam-boats, with ease, in 15 or 20 days; and at the rate of not less than five miles an hour.

Why would steam be advantageous for propelling ploughs and other agricultural implements?

Because, independently of the saving of horses and their food, the farmer would never be obliged to work his soil, but when it was in a proper condition for that purpose. Mr. Loudon thinks that to apply steam successfully to agriculture, the engineer ought not to seek for a new implement, but simply for a convenient locomotive power for propelling the implements already in use, modified so as to suit the new impelling power.

Why are the locomotive engines so advantageous for the conveyance of passengers?

Because they admit a rate of speed that would be entirely inconsistent with safety, even although it were practicable to attain it with animal power. It would be still imprudent, however, to adopt the utmost rate of thirty miles, because such an unusual rate of velocity, surpassing that of the swiftest horse, would be alarming, if it were not dangerous. At the rate of twenty miles an hour, however, it might be perfectly practicable to travel with the utmost safety and comfort. The economy of the plan may be illustrated as follows:—Between Liverpool and Manchester, we may safely estimate the number of passengers every day at 400 each way, and the average fare to be about seven shillings each; the daily expenditure will amount, in this manner, to about 280*l.* By the use of steam-coaches, the fares will be reduced to two-shillings

and sixpence, and would thus amount only to 100*l.* per day, making a daily saving of 180*l.*, or upwards of 60,000*l.* per annum.

The expense of the Liverpool and Manchester Railway, is now estimated at upwards of 20,000*l.* for each mile; the whole cost amounting to 820,000*l.*

The rails used on the Liverpool and Manchester road are made of forged iron, in lengths of five yards each, and weigh thirty-five pounds per yard. Every three feet the rails rest on blocks of stone, let into the ground, containing each nearly four cubic feet. Into each block, two holes, six inches deep, and one inch in diameter, are drilled; into these are driven oak plugs, and the cast-iron chains or pedestals, into which the rails are immediately fitted, are firmly spiked down to the plugs, forming a structure of great solidity and strength. The double lines of rails for the carriages, are laid down with mathematical correctness, and consist of four equi-distant rails, four feet eight inches apart, about two inches in breadth, and rising about an inch above the surface. In the formation of the railway, there have been dug out of the different excavations, upwards of three millions of cubic yards of stone, clay, and soil.

THE STEAM-ENGINE.

Why is heat so important in the production of mechanical agents?

Because bodies, whether liquid, solid, or aeriform, exert a certain degree of mechanical force, in the process of enlarging their dimensions, on receiving an accession of heat; and any obstacle which opposes this enlargement, sustains an equivalent pressure. This force is frequently used as a mechanical agent, and has this to recommend it, that it may be produced to almost any degree of intensity, without the expenditure of any other mechanical force in its production.

It is not requisite to enter theoretically into the production of heat, since the subject has already been popularly illustrated in the present work.*

Why is the steam-engine much more intelligible than its name first suggests?

Because it is in fact only a pump, in which the fluid is made to impel the piston, instead of being impelled by it, that is to say, in which the fluid acts as the *power*, instead of being the *resistance*. It may be described simply as a strong barrel or cylinder, with a closely filled piston in it, which is driven up and down by steam, admitted alternately above and below from a suitable boiler; while the end of the piston-rod, at which the whole force may be considered as concentrated, is connected in any convenient way with the work that is to be performed. The power of the engine is of course proportioned to the size or area of the piston, on which the steam acts with a force, according to the density, of from 15 to 100 or more pounds to each square inch. In some of the Cornish mines, there are cylinders and pistons of more than 90 inches in diameter, on which the pressure of the steam equals the efforts of 600 horses.—*Arnott.*

The steam-engines in England represent the power of 320,000 horses, equal to 1,920,000 men, and being, in fact, managed by only 36,000 men, add consequently to the power of our population, 1,884,000 men.

The cost of a steam-engine varies according to its power. The smaller cost nearly 100*l.*, for each horse power, the largest not quite 400*l.* The consumption of coal is rated at one bushel, or 84 pounds per hour, for an engine of ten-horse power; the quantity is somewhat less in proportion in engines of great power.

Why is there a large vibrating beam in the steam-engine?

Because, one end being connected with the piston-

* See Part V., Chemistry.—*Heat*, p. 21 to 35.

rod, is pulled down, while the power of the engine is applied at the other end to any mechanical purpose. Thus, when connected with immense water-pumps, it causes almost a river of water to gush out from the bowels of the earth.

Why are the improved paddle-wheels of steam-boats made to enter the water sideways?

Because they give the propelling stroke direct, whereas the ordinary wheels press the broad face of their paddles on the surface of the water, and thus increase the resistance.

Why are steam-engines of such important use in mining?

Because they speedily raise the water which breaks in on the miners.

The practical adaptation of the steam-engine to mechanical purposes, is considered by Mr. Davies Gilbert as due to Mr. Newcomen, whose inquiries were introduced into Cornwall very early in the last century, and soon superseded the rude machinery which had, till then, been employed for raising water from mines, by the labour of men and horses.

The various applications of steam-power would occupy many pages: if we except its adaptation to the motion of carriages, perhaps few of its effects are more astounding than in the manufacture of iron. Thus, there are factories where this resistless power is seen, with its mechanic claws, seizing masses of iron, and in a few minutes delivering them out again pressed into thin sheets, or cut into bars and ribands, as if the iron had become soft, like clay in the hands of the potter.

The annual product of the foundries of Messrs. Crawshay and Co. in Glamorganshire, is 11,000 tons weight of pig-iron, and 12,000 tons of iron in bars. A steam-engine of the power of 50 horses, and a water-wheel of 50 feet diameter, work the cylindrical blow-

ing-machines, which are indispensably necessary in the use of coke, and the other machinery of the works. This enormous water-wheel is kept in motion by the pressure of 25 tons of water per minute. The establishment employs from 1,500 to 2,000 workmen, forming, with their families, a population of 4,000 persons. The sum total of their wages amounts annually to from 70,000*l.* to 80,000*l.*

Such has been the progressive improvement in the steam-engine, that in 1829, the best engine in Cornwall did ten times the work of any engine in 1778; or each bushel of coals raised 20,000 gallons of water.

M. Dupin estimates the steam-engines of France equivalent to the power of 480,000 workmen turning a winch; and it is calculated by the same writer, that Great Britain possesses, in steam-engines alone, a moving power equivalent to that of 6,400,000 men employed at the windlass.

Why do high pressure differ from low pressure engines?

Because, in high pressure engines the steam is not condensed; but after having acted on the piston, is allowed to blow off into the air; whereas, in low pressure engines it passes into a separate vessel, where it is condensed; on which account, and for other reasons, low pressure engines do not suit a rail-road. High pressure engines occupy less room, require less fuel than low pressure engines, and their power can be increased on emergencies, by merely increasing the fire; but the risk of damage from explosion is considerable. Their principal purpose is to save water, but this is always abundant in navigation.

The principle of high pressure steam-engines depends on the power of steam to expand itself, 5, 10, 20, 30, 40, &c. times beyond its original bulk, by the addition of a given portion of heat, which is effected by increasing the pressure.

Under mean pressure, at the temperature of 212°. (the boiling point) the bulk of steam is 1,800 times that of water; or, as a ready rule for calculation, a cubic inch of water produces about a cubic foot of steam. The latent heat of steam is about 960°.

Why is Brown's Pneumatic Engine a species of steam-engine?

Because its principle is a very sudden expansion and condensation, not of the gases used in the operation, but of the small quantity of water formed by the combustion of the hydrogen, with the oxygen of the atmospheric air, admitted into the cylinder at every stroke of the engine. The difference between this and a steam engine is, that the elastic and condensable fluid is generated at a higher temperature from materials admitted into the cylinder itself. The extent of the vacuum produced must depend on the temperature at which the combustion takes place.—*Notes in Science.*

Why is the explosive engine so called?

Because it is set in motion by the explosion of oil gas and atmospheric air, the mechanical force of the explosion being employed to drive the machinery. Percussion powder, and other substances that explode by contact, may eventually be employed for the same purpose.

RECENT INVENTIONS AND IMPROVEMENTS.

Why is the printing-press invented by Lord Stanhope so superior to the wooden press, or that previously in use?

Because the Stanhope press is composed entirely of iron; the table on which the types rest, and the platten (or surface which gives the impression) are made perfectly level; a beautiful combination of levers is added, to give motion to the screw, causing the platten to descend with increasing rapidity, and consequently with increasing force, till it reaches the type, when a very great power is obtained. There have been, per-

haps, twenty contrivances for obtaining the same effect; but, as *a press*, Lord Stanhope's invention has not been surpassed. Still, it is only a press, and in point of *expedition* has little superiority over its wooden rival, producing 250 impressions per hour.

It is a remarkable fact, that from the invention of printing to the year 1798, a period of nearly three hundred years, no improvement had been introduced into this important art.*

A mere outline of the improvements from this period would occupy many pages. The great triumph in the art has, however, been the substitution of cylindrical machinery for the screw-press. The *suggestion* of this improvement belongs to Mr. W. Nicholson, but the two first *working* machines were erected by Mr. Koenig, for printing the *Times* newspaper, the reader of which was told, on Nov. 28, 1814, that he held in his hand a newspaper printed by machinery, and by the power of steam!

In these machines the type was made to pass under the cylinder, on which was wrapped the sheet of paper, the paper being firmly held to the cylinder by means of tapes; the ink was placed in a cylindrical box, from which it was forced by means of a powerful screw depressing a tightly-fitted piston; thence it fell between two iron rollers; below these were placed a number of other rollers, two of which had, in addition to their rotatory motion, an end motion, *i. e.* a motion in the direction of their length; the whole system of rollers terminated in two, which applied the ink to the types. In order to obtain a great number of impressions from

* Mr. Buckingham saw in a convent on the mountains of Lebanon, a printing-press and Syriac types, from which the monks produce their church-books, quite equal to those at Rome. The press nearly resembled in shape the common printing-press used in England. It is there considered a mystery, as "they had never yet had an European here, who had ever seen the mechanical operation of printing in Europe." Other monks in the same convent were employed in weaving, masonry, carpentry, &c.

the same form, a paper cylinder (*i. e.* the cylinder on which the paper is wrapped) was placed on each side the inking apparatus, the form passing under both. This machine produced 1,100 impressions per hour; subsequent improvements raised them to 1,800 per hour.

The next machine, also by Mr. Koenig, was for printing both sides of the sheet, by conveying the sheet from one paper cylinder to the other. This was made in 1815, and printed 750 sheets on both sides per hour. In the same year Mr. Cowper obtained a patent for curving stereotype plates, for fixing them on a cylinder. Several of these machines, capable of printing 1,000 sheets per hour on both sides, are at work at the present day; and twelve machines on this principle were made for the Bank of England, a short time previous to the recent issue of gold. These machines, though only adapted for stereotype printing, first showed the best method of furnishing, distributing, and applying the ink by rollers.

Messrs. Applegath and Cowper have, however, by their conjoint ingenuity, superseded Mr. Koenig's inventions, and constructed upwards of 60 machines, modified in twenty-five different ways, for printing books, bank-notes, newspapers, &c.: their greatest success has been in printing newspapers. In the *Times* machine, which was planned by Mr. Applegath, the form passes under four printing cylinders, which are fed with sheets of paper by four lads, and after the sheets are printed, they pass into the hands of four other lads; by this contrivance 4,000 sheets per hour are printed on one side.

The comparative produce of the above machines is as follows:—

Stanhope press	- - -	250 impressions per hour.	
Koenig's machine	- - -	1,800 i. e.	900 on both sides.
Cowper's (stereotype)	- -	2,400 i. e.	1,200 ditto.
Applegath and Cowper's (book)		2,000 i. e.	1,000 ditto.
Ditto (newspaper) Chronicle	-	2,000	
Herald	-	2,400	
Times	-	4,000—66 per minute.	

We have principally abridged these facts and data from a valuable paper communicated by Mr. Cowper, one of the inventors, to the Royal Institution, and subsequently to the *Quarterly Journal of Science*, in the year 1828.

The machine for printing the *Atlas* newspaper, (each copy of which, in some cases, has contained 40 feet of printed superficies) consists of two larger and two lesser cylinders, put in motion by a steam-engine of 4-horse power, managed by three boys, whose only task is to present the end of the enormous blank sheet to the first cylinder, and to receive it, in a few seconds, printed on both sides, as it is discharged by the last cylinder.

Why will some machines produce paper of indefinite length?

Because in them the pulp is delivered from the trough to an endless web of wire, passing over cylinders, which are turned by steam, or any other prime mover. From the wire web it passes between two rollers to an endless web of felt, which passes over other cylinders, and between two other heavy rollers, for the expression of the water; the paper is thence wound upon a reel, and when a sufficient quantity is received on it, the paper is cut off, and removed to the drying-house. At White Hall Mill, in Derbyshire, a sheet of paper was lately manufactured which measured 13,800 feet in length, 4 feet in width, and would cover an acre and a half of ground.

Why does beating books with a hammer cause the printing to "set off" on the opposite page?

Because the blows suddenly compress the air between the leaves, and create heat which disturbs the ink.

Why has pressing been advantageously substituted for this beating?

Because it renders the books extremely compact and solid, by passing the sheets, when folded, between

a pair of powerful rollers, by which much time is saved, the paper is made smoother, and the compression, though greater, does not disturb the ink. A rolled book will thus be reduced to about five-sixths of the thickness of the same book, if beaten: a shelf, therefore, that will hold fifty books beaten in the usual manner, will hold nearly sixty of such, if rolled.—*Trans. Soc. Arts.*

Why are knives sharpened by being drawn between two horizontal rollers, as in "the patent knife-sharpener?"

Because the rollers revolve freely upon their axis; and at uniform distances are fixed narrow cylinders, or rings of steel, the edges of which are finely cut with file teeth, forming thereby circular files; the edges of these files overlap or intersect each other a little, so that when a knife is drawn between them, it operates on both sides of the edge at once; and as the rollers turn round at the slightest impulse, the peripheries of the circular files get uniformly worn, and consequently will last a long time.

Why does the transparent dial of St. Giles's church, London, light itself with gas as soon as the sun sets at night, and put out the light when the sun rises in the morning?

Because a wheel is connected with the clock, which makes but one revolution in twenty-four hours; and on this is placed a series of pins, which, by their revolution with the wheel, tend to raise a lever connected both with a gas-cock and a movable screen. The gas which illuminates the dial is burning at all times, but the consumption during the day is comparatively small, as the lever opens and shuts the aperture by the motion of the large wheel; so that a person in the immediate neighbourhood of the clock would see little more than a faint indication of flame during the day light; but at evening the lever opens the aperture to its full size, and lets forth a brilliant flame. The movable screen completely cuts off any portion of light

which might otherwise pass from the partially closed burner.—*Mr. C. F. Partington, in the Atlas Newspaper.*

Why are the faces of many new public clocks made of stone instead of metal?

Because stone being an absorbent, and not so good a conductor of heat as metal, the paint adhères better and lasts longer, and does not require to be renewed so often as on the copper dial. Another advantage of the stone dial is, that the centre can be sunk, and the hour hand made to traverse in the sinking. This enables the minute-hand to be close to the figures, and then almost all error from the effect of parallax is avoided, which in the copper dial is very considerable; especially when the minute-hand points at or near 15 and 45 minutes, and the hands are both above the dial. In the stone dials of Chelsea new church, and the Royal Mews, Pimlico, the figures are cut in the stone, and sunk about the eighth of an inch, after the manner of the Egyptian monuments, from which was derived the idea. By this method, supposing the dial accurately divided, and the figures well shaped in the first instance, they will always remain so.—*Mec. Mag.*

The originator of this improvement is Mr. Vulliamy, the eminent horologist.

Why is the Diorama so called?

Because of its origin from the Greek, signifying two views, of which this exhibition consists. These pictures are painted in solid, and in transparency, arranged and lighted in a peculiar manner, so as to exhibit changes of light and shade, and a variety of natural phenomena. The means by which these changes are effected, may be explained as follows:—The contrivance is partly optical, partly mechanical; and consists in placing the pictures within a building so constructed, that the saloon containing the spectators may revolve at intervals, for the purpose of bringing in succession two distinct pictures into the field of view, without the necessity of the spectators removing from

their seats; while the scenery itself remains stationary, and the pictures therefore admit of an improved method of distributing light, by which they are illuminated, so as to produce the effects of a variable picture. This is performed by means of a number of transparent and movable blinds, some of which are placed behind the picture for the purpose of intercepting and changing the colour of the rays of light, which are permitted to pass through the semi-transparent parts of the picture. Similar blinds are also situated above and in front of the pictures, so as to be movable by the aid of cords, and by that means to distribute or direct the rays of light which are permitted to fall upon the front of the scene.

The extent of revolving motion given to the saloon, is an arc of about 73°; and during the time that the audience is thus passing round, no person is permitted to go in or out. The revolution of the saloon is effected by means of a sector, or portion of a wheel, having teeth formed upon its edge; these work in a series of wheels and pinions, so that one man placed at a winch is enabled to give motion to the whole.

The space between the saloon and each of the two pictures is occupied on either side by a partition, forming a kind of avenue, proportioned in width to the size of the picture; without such a precaution, the eye of the spectator being thirty or forty feet distant from the canvass, would, by any thing intervening, be estranged from the object. The views are eighty-six feet in length and forty-five feet in height.—*Atlas.*

END OF PART VII.

KNOWLEDGE FOR THE PEOPLE:

OR THE

PLAIN WHY AND BECAUSE.

PART VIII.—ZOOLOGY—AMPHIBIA, FISHES, &c.

ZOOLOGY.

AMPHIBIA.

GENERAL ECONOMY.

Why are the bones of reptiles and fishes softer than those of quadrupeds and birds?

Because the former contain much less earthy matter than the latter. In some fishes, the earthy matter is so small, that the cartilage continues, during the whole life of the animal, soft, flexible, and elastic, as the spine of the lamprey; or a little more indurated (harder) as in the bones of the skate or shark. These fishes have been termed cartilaginous. Even in those fishes which are termed osseous, (or bony,) the cartilage bears a much greater proportion to the earthy matter than in quadrupeds.—*Fleming.*

Why may the circulation of reptiles be considered as imperfect?

Because only a part of the blood is aërated, which issues from the heart; and that portion, instead of proceeding directly to the different organs, is again mixed with the circulating fluid.—*Fleming.*

Why do Amphibia resemble Mammalia, and differ from Fishes?

Because they breathe with lungs; although these are of a much looser texture; and their respiration much more indeterminate, and less regular, than in the two classes of warm-blooded animals.—*Blumenbach.*

They are capable of living much longer without respiring, or in a vacuum, (as, for instance, toads in cavities, within trees, or blocks of stone); they can even

endure for a time, an atmosphere of carbonic acid gas; and there are undoubted proofs of newts and frogs having lived in the stomachs of human beings, or that have recovered, after having been frozen perfectly hard.

Why are certain animals, as amphibia and fishes, called cold-blooded?

Because their temperature is greatly influenced by that of surrounding objects.

In this, and warm-blooded animals, as mammalia and birds, whose temperature is high, and not greatly influenced by the changes in the heat of external objects, the temperature is regulated by the vital powers of the animals; and limits are assigned, beyond which it is dangerous to pass.

The range of warm-blooded animals is confined; that of cold-blooded animals extensive.

Why have amphibia the remarkable facility and strength of reproduction?

Because of the force of their nerves, and the comparatively small size of their brain; as a consequence of which, the nerves are less dependent on the brain; the whole machine has less mobility, presents fewer indications of sympathy, and the whole life is more simple, and more purely vegetative, than in warm-blooded animals; whilst, on the other hand, the separate parts are endowed with a greater share of peculiar and independent vital power; whereas, a stimulus applied to one part, or one system of parts, does not, as in warm-blooded animals, excite others by sympathy.

We have thus an explanation of the tenacity of life in animals of this class; (frogs are known to leap about after the heart has been torn out, and tortoises to live for months, after the brain has been removed), and a similar explanation will apply to the long-continued power of motion, in parts of amphibia, when separated from the bodies; as the tails of newts, blindworms, &c.

As an instance of extraordinary reproduction, Blumenbach tells us of a large water-newt, one of whose eyes had been entirely extirpated; notwithstanding which, within ten months, a perfect new eye was formed, with cornea, pupil, lens, &c. and only differing from the eye on the other side, in being about half its size.

Why are amphibia considered slow in growth?

Because, for example, the frogs of these climates are incapable of producing until their fourth year; and yet reach what must be considered in proportion to the late period of puberty, the inconsiderable age of from twelve to sixteen years. On the other hand, it is known, that tortoises, even in captivity, have lived upwards of one hundred years; so that, by analogy, it may be supposed, that crocodiles, and the large serpents, reach a still more advanced age.—*Blumenbach.*

Why is the gullet of reptiles usually dilatable?

Because their teeth, in general, are fitted for retaining their food, rather than for masticating it.

One of the most remarkable instances of dilatation, was witnessed in a Boa, brought to Europe in 1817, in the vessel in which Lord Amherst returned from India. This boa, was only about 16 feet long, and 18 inches in circumference; but, on a live goat being thrust into his cage, he seized the poor creature by the fore-leg, with his mouth, and, throwing it down, it was instantly encircled in his folds; and, so quickly, that the eye could not follow the rapid motion of his long body, as he wound it round the goat; its cries became more and more feeble, and at last it expired. The snake, however, long retained his grasp, after it was motionless. He then slowly and cautiously unfolded himself, and prepared to swallow it. He commenced, by covering the dead animal over with his saliva; and then taking its muzzle into his mouth, he sucked it in as

far as the horns would allow. These opposed some little difficulty, but they soon disappeared externally; yet their progress might be traced distinctly on the outside, threatening every moment to protude through the skin. The whole operation of completely gorging the goat, occupied about two hours and twenty minutes; at the end of which time, the tumefaction was confined to the middle part of the body, or stomach; the superior parts, which had been so much stretched, having resumed their natural dimensions. He now coiled himself up again, and lay quietly in his usual torpid state, for about a month, till his last meal appearing completely digested and dissolved, he was ready for other food, which he devoured with equal facility. Between the Cape of Good Hope and St. Helena, he was, however, found dead in his cage; and, on dissection, the coats of the stomach were discovered to be excoriated and perforated by worms. Nothing remained of the goat, except one of the horns, every other part being dissolved.

A boa, about 9 feet long, was exhibited in London, in 1817. He was fed on live rabbits, ducks, &c., which he also despatched, by coiling his body two or three times round them, crushing them to death, and then gulping them down by the aid of saliva.

Why are serpents, (as in the case of the boa just mentioned) enabled to swallow such large bodies whole?

Because the upper jaw is loosely connected with the head; and, in some species, admits of considerable motion at the point of junction, by which means the mouth can be opened very wide.

Why do reptiles crawl?

Because the limbs are placed perpendicular to the mesial line; and, in the progressive motion, the body is dragged along the ground, as the flexion and extension of the limbs are unable to elevate it above the surface.—*Fleming.*

Why may animals with many feet be said to glide along a surface?

Because their walking is performed by so uniform a motion, the feet not moving by pairs, but by divisions, containing from five to twenty, and upwards. The hairs on the rings of caterpillars, it may be here observed, likewise serve as feet, in assisting progressive motion.

Why have certain reptiles a serpenti-form motion?

Because they bring up the tail towards the head, by bending the body into one or more curves, then resting upon the tail, and extending the body, thus moving forward, at each step, nearly the whole length of the body, or one or more of the curves into which it was formed. In serpents, this motion is well displayed, whence its name; and, in some cases, it would appear, that they are assisted in it by means of their ribs, which act as feet. Among the *mollusca*, (or soft animals) and the *annulosa*, (or ring-jointed animals) the same kind of motion is performed, by alternate contractions and expansions, laterally and longitudinally, of the whole or parts of the body. The hairs or spines of many of the annulosa, assist their progress; while in others, the body is so soft and pliable, as easily to accommodate itself to the inequalities of the surface over which it glides, and derive assistance from these in its progress.

Why do reptiles become torpid during winter?

Because, chiefly, of the cold acting on a frame extremely sensible to its impressions. During the continuance of a high temperature, they remain active and lively; but when the temperature is reduced towards 40°, they become torpid, and in this condition, if placed in a situation where the temperature continues low, will remain torpid for an unknown period of time. Spallanzani kept frogs, salamanders, and snakes, in a torpid state, in an ice-house, where they

remained three years and a half, and readily revived when again exposed to the influence of a warm atmosphere.

Why do reptiles respire very slowly during their torpidity?

Because the circulation of the blood is carried on independent of the action of the lungs. Even in a tortoise, kept awake during the winter by a genial temperature, the frequency of respiration was observed to be diminished.

The circulation of the blood is diminished, in proportion to the degrees of cold. Spallanzani counted from 11 to 12 pulsations in a minute in the heart of a snake, at the temperature of 48°, whose pulse in general, in warm weather, gives about 30 beats in the same period. Dr. Reeves observed the number of pulsations in toads and frogs, to be 30 in a minute, whilst they were left to themselves in the atmosphere, of which the temperature was 53°; when placed in a medium, cooled to 40°, the number of pulsations was reduced to 12 within the same period; and when exposed to a freezing mixture at 26°, the action of the heart ceased altogether. The powers of digestion are likewise equally feeble.

Why has the immediate cause of torpidity in reptiles, been ascertained with more precision than in animals with warm blood?

Because this condition with them, does not depend on the state of the heart, the lungs or the brain; for these different organs have been removed by Spallanzani, and still the animal became torpid, and recovered according to circumstances. Even after the blood had been withdrawn from frogs and salamanders, they exhibited the same symptoms of torpidity, as if the body had been entire, and all the organs capable of action.

Why are there but few reptiles in the cold countries of the globe?

Because they are so easily acted upon by a cold atmosphere; while in those countries enjoying a high temperature, they are formed of vast size, of many different kinds, and in great numbers.

REPTILES.

TORTOISE TRIBE.

Why are tortoises enabled to bear such immense weights?

Because most of them are covered with a firm long shell, the upper part of which is connected with the spine and ribs, and is covered by the broad horny plates, which in many species are so firm, and of such beautiful colours as to be employed for various purposes of art. There are usually thirteen such plates in the middle, and twenty-four round the edges. The under-shell, covering the belly, is somewhat smaller than the upper, with openings for the head, the tail, and the feet.

In a Singapore newspaper we read, that the tortoise, when caught by the Eastern islanders, is suspended over a fire, kindled immediately after its capture, until the effect of the heat loosens the shell, so that it can be removed with the greatest ease. The animal, now stripped and defenceless, is set at liberty. If caught in the ensuing season, or at any subsequent period, it is asserted that the unhappy animal is subjected to a second ordeal of fire, rewarding its captors this time, however, with a very thin shell.

We do not quote this fact for its refinement of cruelty, but to prove the tenacity of life in the tortoise, which must be accounted a very singular fact in natural history.

Blumenbach observes, that the peculiar and distinct form of this consequently isolated genus, forms a very strong proof of the non-existence of the supposed gradation of objects in nature.

Why have animals of the tortoise tribe, usually jaws provided with a horny covering, like the bills of birds?

Because they are destitute of teeth.

Why do these animals deposit their eggs in the sand?

Because they may there be hatched by the heat of the sun. A single nest has been known to furnish 500 eggs.

Why are the eggs of the land-turtle more likely to be discovered than those of the water-turtle?

Because the former leaves its eggs, one by one, as it hobbles over the ground, neither covering nor taking any care of them whatever, nor paying any regard to the offspring. The water turtle, on the contrary, covers its eggs so accurately as to leave no signs perceptible of its nest; and, however strange it may seem, she so arranges it as to make her tract appear unbroken over the sands, and, after laying her eggs, she proceeds on again in the same direction to complete the deception.

Why is the flesh of the green turtle so well-tasted, and free from oil?

Because it feeds solely on sea-weeds. It is named from the pale olive-green colour of the shell, and the still more remarkably green colour of its fat. This species sometimes weighs 800 weight.

Why is the geometrical tortoise so called?

Because its high-arched shell is *very regularly* marked with black and yellow.

FROGS AND TOADS.

Why have certain frogs been fabulously said to change into fishes?

Because their larva is almost a span long, and then much larger than the perfectly formed animal. The animal also retains its tail for some time after the four legs have acquired their perfect form and size.

Why is the tree frog so called?

Because it climbs trees in search of insects; for

which purpose it has the extremities of the toes expanded, with suckers beneath.

The clammy slime with which it is covered, like serpents, serves also to support it among the leaves of the trees in which it lives.

Why was it formerly believed to rain frogs?

Because the young of the common frog living in grass, among bushes, &c. come out in vast numbers, after warm summer showers.—*Blumenbach.*

Stories of showers of frogs have, however, obtained credence in our times. Mr. Loudon observes, when at Rouen, in September, 1829, "we were assured by an English family resident there, that during a very heavy thunder shower, accompanied by violent wind, and almost midnight darkness, an innumerable multitude of young frogs fell on and around the house. The roof, the window-sills, and the gravel walks were covered with them. They were very small, but perfectly formed, all dead; and the next day being excessively hot, they were dried up to so many points or pills, about the size of the heads of pins. The most obvious way of accounting for this phenomenon is by supposing the water and frogs of some adjoining ponds to have been taken up by the wind in a sort of whirl or tornado."—*Magazine of Nat. Hist.*

Why does the skin of the frog and toad resemble a bag containing the animal?

Because it does not adhere to the subjacent parts, as in other animals, but is attached to them only at a few points, and is unconnected elsewhere.

According to old Walton, "the mouth of the frog may be opened from the middle of April till August, and then the frog's mouth grows up, and he continues so for at least six months without eating."

Why are toads sometimes found alive inclosed in stones, &c.?

Because the animals have entered a deep crevice of

the rock, and becoming torpid, have been covered with sand, which has afterwards concreted around them. Thus removed from the influence of the heat of spring or summer, and in a place where the temperature continued below the point at which they revive, it is impossible to fix limits to the period during which they may remain in this torpid state.

Such is the explanation of this phenomenon, by Dr. Fleming. An ingenious French naturalist, M. Geoffrey St. Hilaire, thinks it gives a very inaccurate idea of the phenomenon, "to assimilate the state of these beings whose lives are preserved in torpidity to the animals benumbed during winter." According to his theory, we must conclude that "there exists, for organization under certain combinations, a state of neutrality intermediate between that of life and death, a state into which certain animals are plunged in consequence of the stoppage of respiration, when it would take place under determinate circumstances.

Why is "star-shot jelly" so often seen floating on ponds, &c.

Because frogs are then spawning, and this consists of the glaire which surrounds the eggs, brought into this state by a frog having been swallowed by a bird, and the warmth and moisture of the stomach having made the jelly and the oviducts expand so much, that the bird is obliged to reject it by vomiting.

CROCODILE, ALLIGATOR, &c.

Why is the crocodile an object of superstitious terror to the Egyptians?

Because of its immense size and destructive powers, it being the largest animal inhabiting fresh water, attaining to full 30, or, as Norden says, 50 feet in length; notwithstanding which, its eggs are scarcely as large as a goose's. When full grown, it attacks men and other large animals. When taken young, it may be tamed. The armour, with which the body is covered,

may be considered as one of the most elaborate pieces of natural mechanism. In the full-grown animal it is so strong as easily to repel a musket-ball, appearing as if covered with the most regular and curiously carved work.

Mr. Bullock, late proprietor of a museum in Piccadilly, saw, at New Orleans, "what are believed to be the remains of a stupendous crocodile, and which are likely to prove so, intimating the former existence of a lizard at least 150 feet long; for I measured the right side of the under jaw, which I found to be 21 feet along the curve, and four feet six inches wide."

The teeth of crocodiles have this peculiarity of structure, that in order to facilitate their change, there are always two, of which one is contained in the other.

As a proof of the veneration in which the crocodile was formerly held, we are told by Herodotus, that near Thebes and the Lake Mœris, the natives select one, which they tame, suspending golden ornaments from its ears, and sometimes precious stones of great value; the fore-feet, however, being secured by a chain. They feed it with the flesh of the sacred victims, and with other suitable food; and when it dies it is embalmed, and deposited in a consecrated chest.

Various methods are adopted for catching crocodiles. Labat says, "a negro, armed only with a knife in his right hand, and having his left wrapped round with thick leather, will venture boldly to attack the crocodile in his own element. As soon as he observes his enemy near, the man puts out his left arm, which the animal immediately seizes with his teeth. He then gives it several stabs in the throat, where the skin is very tender; and the water coming in at the mouth thus involuntarily laid open, the creature is soon destroyed." A still more hazardous method was adopted by Mr. Waterton, who travelled in south America

about five or six years since. Having secured a crocodile of the Essequibo, by a baited hook fastened to a long rope, by the aid of some Indians, "I pulled the animal," says the traveller, "within two yards of me; I saw he was in a state of fear and perturbation; I instantly sprung up, and *jumped on his back;* turning half round as I vaulted, so that I gained my seat with my face in a right position. I immediately seized his fore legs, and by main force twisted them on his back; thus they served me for a bridle."

On his return home, Mr. Waterton published his Travels; but the *jumping on the crocodile* was received by his readers as a traveller's story, till its possibility was established by reference to Pliny's *Natural History*, where it is stated that the natives of Tentyra mount on the crocodile's back "like horsemen, and as he opens his jaws to bite, with his head turned up, they thrust a club into his mouth, and holding the ends of it, they bring him to shore captive, as if with bridles." Other proofs are quoted in the *Magazine of Natural History*, for 1830.

Why does the alligator differ from the crocodile?

Because the body and tail are more round and smooth than the true crocodile; it is also smaller, and has smaller eggs. Like it, however, it has five toes on the fore feet, and four on the hinder, of which only the three inner ones are provided with claws.

Why do alligators swallow stones when going in search of prey?

Because (as the Indians on the Orinoco assert) they may acquire additional weight to aid them in diving and dragging their victims under water. A traveller being somewhat incredulous on this point, Bolivar, to convince him, shot three alligators with his rifle, and in each of them were found stones varying in weight according

to the size of the animal. The largest killed was about 17 feet in length, and had within him a stone weighing about 60 or 70 pounds.

Why is the cayman neither safe on land nor in water?

Because it is driven into the water by the tiger and other enemies; whence it is made to scamper ashore by the porpess, the natural enemy and entire master of the cayman; so much so, indeed, that the natives enter the water without fear when the porpess is in sight.

Why was the crocodile formerly believed to be vanquished by the ichneumon?

Because eggs of crocodiles form the favourite food of the ichneumon, wherefore, this portion of its history became mingled in early times with the above fanciful notion. Divine honours were accordingly awarded to the ichneumon by the ancient Egyptians, and it became, and continued for ages, an object of superstitious reverence to a people prone to this symbolical worship of the powers of nature.

Ichneumons are still domesticated in Egypt, where they rid the houses of the smaller animals, and perform the office of our domestic cat.

Why may the hippopotamus be classed with amphibia? *

Because it runs with astonishing swiftness, for its great bulk, at the bottom of lakes and rivers. At one time it was not uncommon in the Nile, but now is nowhere to be found in that river, except above the cataracts.

The head of a hippopotamus was brought to England about four years since, with all the flesh about it, in a high state of preservation. This animal was harpooned whilst in combat with a crocodile, in a lake in the interior of Africa. The head measures near four

* The hippopotamus is, strictly speaking, a quadruped, but its habits being amphibious, entitle it to mention here, especially in connexion with the crocodile, to which it is a ferocious enemy.

feet long, and eight feet in circumference: the jaws open two feet wide, and the cutting-teeth, of which it has four in each jaw, are above a foot long, and four inches in circumference. This formidable creature, when full-grown, measures about 17 feet long from the extremity of the snout to the insertion of the tail, above 16 feet in circumference round the body, and stands above seven feet high. When excited, it puts forth its full strength, which is prodigious. "I have seen," says a mariner, as we find it in Dampier, "one of these animals open its jaws, and seizing a boat between its teeth, at once bite, and sink it to the bottom. I have seen it, on another occasion, place itself under one of our boats, and rising under it, overset it with six men who were in it, but who, however, happily received no other injury."

Why is a species of lizard called the monitor?

Because it is said to keep in company with the crocodile, and to warn, by its whistling noise, of the proximity of its formidable associate.

Why is another species of lizard called the flying dragon?

Because it flies or takes short leaps from tree to tree, by having, on each side of the body, a membranaceous wing, scarcely connected with the legs. It is supported by the first six false ribs, which instead of being bent round towards the belly, for the protection of the viscera, proceed laterally from the body.

CHAMELEON.

Why does the chameleon change colour?

Because of the circulation of the blood of the reptile, in increased temperature, either of the ambient air or of its own body, producing all the variations of the skin. As the passions of the human mind change the colour of the skin, as well as the form of the features, and according to the rapidity of the flow of blood; so the feelings of the chameleon may also, in some mea-

sure, produce analogous changes in the reflecting surface of the skin.—*J. Murray, F. L. S.*

The reflection of coloured objects on the glittering scales of the chameleon, probably gave origin to the fable that its colour is regulated by that of the bodies near which it is placed.—*Notes to Blumenbach.*

Whatever may be the cause, the fact seems to be certain, that the chameleon has an antipathy to things of a black colour. One, which Forbes kept, uniformly avoided a black board which was hung up in the chamber; and, what is most remarkable, when it was forcibly brought before the black board, it trembled violently, and assumed a black colour.

It may be something of the same kind which makes bulls and turkeycocks dislike the colour of scarlet, a fact of which there can be no doubt.—*J. Rennie.*

Why was the chameleon formerly said to feed on air?

Because its lungs are very large, and by expanding them, the animal can, at pleasure, make itself appear large or small.

Why do the eyes of the chameleon differ from those of other amphibia?

Because they can be directed in different ways; for instance, one upwards and the other backwards; and that with great rapidity.

Why may the mechanism of the tongue of the chameleon be compared with that of the woodpecker? *

Because the chameleon's tongue is contained in a sheath at the lower part of the mouth, and has its extremity covered with a glutinous secretion: it admits of being projected to the length of 6 inches, and is used in this manner by the animal in catching its food, which consists of flies, &c. It is darted from the mouth with wonderful celerity and precision, and the secretion on its extremity entangles the small animals which constitute the food of the chameleon.

*See the *Woodpecker*, page 102.

The form of the chameleon's tongue is, however, very different from that of the woodpecker.—*Notes to Blumenbach.*

GECKO.

Why is the gecko so dangerous a reptile in houses?

Because it has a poisonous fluid between its scaly toes, which it communicates to the eatables over which it passes. It is common in Egypt, the East Indies, and the South Sea Islands, and even in some parts of Europe, as in the Kingdom of Naples.

Why do some lizards climb perpendicular walls, like the common house-fly?

Because they have suckers on the under side of the toes, the surfaces of which are broad. They consist of transverse pouches, with fringed margins.

THE PROTEUS.

Why has the classification of the proteus animal been so much controverted among naturalists?

Because its characteristics are equally those of a lizard and a fish.

Sir Humphry Davy, in his *Consolations in Travel,* (to which work we have already referred in *Popular Chemistry*), describes this extraordinary animal as "a far greater wonder of nature than any of those which the Baron Valvasa detailed to the Royal Society, a century and a half ago, as belonging to Carniola, with too romantic an air for a philosopher." Sir Humphry saw the proteus in a lake, in the beautiful grotto of Maddalena, at Adelsburg, in Illyria. "At first you might suppose it to be a lizard, but it has the motions of a fish. Its head, and the lower part of its body, and its tail, bear a strong resemblance to those of the eel; but it has no fins; and its curious bronchial (or lung-like) organs are not like the gills of fishes; they form a singular vascular (net-like) structure, almost like a crest round the throat, which may be removed without occasioning the death of the animal, who is likewise

furnished with lungs. With this double apparatus for supplying air to the blood, it can live either below or above the surface of the water. Its fore-feet resemble hands, but they have only three claws or fingers, and are too feeble to be of use in grasping or supporting the weight of the animal; the hinder feet have only two claws or toes, and in the larger specimens are found so imperfect as to be almost obliterated. It has small points in place of eyes, as if to preserve the analogy of nature. It is of a fleshy whiteness, and transparency in its natural state, but when exposed to light, its skin gradually becomes darker, and at last gains an olive tint. Its nasal organs appear large; and it is abundantly furnished with teeth, from which it may be concluded, that it is an animal of prey; yet, in its confined state, it has never been known to eat, and it has been kept alive for many years, by occasionally changing the water in which it was placed."

Sir Humphry does not think the proteus is bred in the lake in the grotto: "in dry seasons they are seldom found here, but after great rains they are often abundant. I think it cannot be doubted, that their natural residence is an extensive, deep, subterranean lake, from which, in great floods, they sometimes are forced through the crevices of the rocks into this place." We have not space for this great philosopher's theory of the proteus; but we may state its conclusion: "the problem of the re-production of the proteus, like that of the common eel, is not yet solved; but ovaria have been discovered in animals of both species, and in this instance, as in all others belonging to the existing order of things, Harvey's maxim of '*omne vivum ab ovo*,' (every animal from an egg) will apply." The curious reader should turn to the "*Consolations*" for Sir Humphry's ingenious speculations on this and many other striking phenomena of nature: indeed, every page of that work is penned in a delightful strain of deep-souled philosophy.

SERPENTS.

Why may the ventral, or belly-plates, or scales of serpents, be considered as their feet?

Because these scales slide under each other by a kind of inclusion, so as to permit the ventral surface to shorten or lengthen at the will of the animal. When some of the foremost scales are pressed on the ground, those behind are brought forward, and in their turn supporting the body, enable the forepart to advance. To qualify the scales to do this with greater advantage, they are connected with one another, by means of muscular threads and a longitudinal band, and are likewise aided by the peculiar mechanism of the ribs, which last are connected with the ventral scales by a flexible cartilage. The body, in general, is of a rounded form, but, when preparing for progressive motion, the ribs are drawn so as to flatten the scales of the belly, and by moving anteriorly or posteriorly, give to the scales with which they are connected, a corresponding degree of motion. The ribs in this case act as limbs to the scales, which may be compared to feet. This singular use of the ribs of snakes, in assisting progressive motion, was detected by the acute Tyson, and has been still further illustrated by Sir Everard Home.—*Fleming*.

Sir Everard Home was led to this discovery of the aid afforded by the ribs, to the whole tribe of snakes, in the progressive motion of those animals, by the following circumstances. A snake of unusual size, brought to London to be exhibited, was shown to Sir Joseph Bankes; the animal was lively, and moved along the carpet briskly; while it was doing so, Sir Joseph thought he saw the ribs move forward in succession, like the ribs of a caterpillar. The fact was readily established, and Sir Everard felt the ribs with his fingers, as they were brought forward: when a hand was laid flat under the snake, the ends of the

ribs were distinctly felt upon the palm, as the animal passed over it. This was an interesting discovery, as it tended to demonstrate a new species of progressive motion, and one widely different from those already known.—*Notes to Blumenbach.*

Of all animals, serpents possess by far the greatest number of ribs; which amount, in some, to 250 pairs.

Why have snakes a bag between the nose and the eye?

Because they have no glands to supply the skin with moisture from within, but receive it by coming in contact with moist substances: it is possible, therefore, that the bags in the snake may be supplied in that manner, and the more so, as the cuticular lining appears perfect. Another peculiarity is remarkable in snakes so furnished; namely, an oval cavity, situated between the bag and the eye, the opening into which is within the inner angle of the eyelid, and directed towards the cornea, (or transparent membrane to protect the anterior surface of the eye.) In this opening there are two rows of projections, which appear to form an orifice capable of dilatation and contraction. From the situation of these oval cavities, they must be considered as reservoirs for a fluid, which is occasionally to be spread over the cornea; and they may be filled by the falling of the dew, or the moisture shaken from the grass through which the snake passes.—*Sir E. Home.*

Why are scales of different colours?

Because they derive their colours from the mucus web on which they are placed, and this differs in various animals.

The composition of scales, observes Dr. Fleming, is similar to that of the cuticle, with the addition of some earthy salts. They appear to be inserted in that layer of the skin, and to resemble it in many of their properties. When rubbed off, they are easily renewed, and frequently experience the same periodical reno-

vations as the cuticle. In reptiles, scales occur on every part of the body, and are placed laterally in some; whilst in others they are imbricated like the slates of a house. In fishes, the scales are usually imbricated, with the epidermis enveloping their base, and the other edge free. They may also be observed on many insects, exhibiting great varieties of form. What are termed feathers on the wings of butterflies, seem to be a variety of scales.

Why are serpents said to leap?

Because they fold their bodies into several undulations, which they unbend all at once, according as they wish to give more or less velocity to their motion.

The body of some serpents is thrown by the muscles into a very rigid state, when irritated; in which condition it breaks into fragments by the slightest stroke.

Why do many serpents easily swim?

Because they have very long and bladder-like lungs, and the hinder part of the body and tail is much depressed.

Why do some serpents twist their bodies round the branches of trees, or suffer a considerable portion to hang down.

Because, in this attitude, the larger kinds are ready to fall down upon the prey passing beneath, such as deers and antelopes. Such animals are not only retarded by their weight, but incommoded by the foe twisting itself in wreaths round their body, and by contractile efforts crushing it to death.

Why are serpents so speedily extirpated in civilized countries?

Because, not only is man their inveterate personal foe, but he receives powerful support from many of the domestic animals which accompany him in his dispersion over the globe. The hog is not afraid to give battle to the most venomous; and, in general,

comes off victorious. The goat likewise readily devours the smaller kinds of serpents, and hence the proverb from the Gaelic, "like the goat eating the serpent,"—importing a querulous temper in the midst of plenty.—*Fleming.*

Why are snakes supposed to fascinate other animals?

Because they may more readily entice and secure them for food. Such is the opinion of Professor Silliman, from his observation of two birds who were enticed, and not pursued, by a large black snake in America. "What this fascinating power is," observes the Professor, "whether it be the look or effluvia, or the singing by the vibration of the tail of the snake, or any thing else, I will not attempt to determine—possibly this power may be owing to different causes in different kinds of snakes.

Dr. Hancock, in a recent contribution to *Jameson's Journal*, however, combats this opinion of the *fascination* of serpents, by saying, "it is not a faculty of charming or of fascinating, in the usual acceptation of the term, which enables certain serpents to take birds; but, on the contrary, the hideous forms and gestures, which strike the timid animals with impressions of horror, stupefying them with terror, and rendering them unfit for any exertion; especially as those serpents to which has been ascribed the power of fascinating, are among the most terrific of the tribe.

Why are dragons represented in fable with ringed bodies?

Because they originated in the *ringed* snake, which, even in Europe, has been found ten feet in length and upwards. Its colour is steel-gray, wherefore the dragon is often so coloured.

Why are venomous serpents distinguishable from those which are not so?

Because of the poison-teeth, which are placed on the anterior edge of the upper jaw, with the corres-

ponding increase in the size of the latter; while, in the harmless serpents, the whole of the outer edge of the upper jaw is furnished with teeth, even to the very back part.—*From the German.*

Among the other characters of distinction, are the broader and heart-shaped head of the venomous, with small flat scales, instead of a single plate; the tail-shaped ridge on the back; and the shorter tail, which measures less than one-fifth of the animal.—*Dr. Gray, in Philos. Transac.*

The number of known venomous species, compared to those which are not so, is reckoned as one to six.

Why are the fangs of some serpents called poison fangs?

Because they contain a tubular cavity from their base (where is the poison bag) passing through a tooth on its convex side, to the apex, where it ends in a narrow slit. When the serpent bites an animal, the poison flows from the bag through this slit, into the bottom of the wound, where to most advantage it can produce its deleterious effects. The properties of the poison continue even after it has been dried. If instilled into the wound, in any quantity, and it enters any of the larger vessels, death speedily follows. The virulence of the poison depends not only on the species of serpent, but on its condition at the time, and the habit of body of the animal which has received the bite.

Why is the cobra di capello also called the hooded snake?

Because, when irritated, the skin on the neck is expanded and drawn forwards, and appears behind the head as a kind of hood. This motion is produced by the cuticular muscles of the neck, aiued by the movable ribs.

Why do the snake-catchers of India handle with impunity the most venomous serpents?

Because they rub their hands, previously to taking

hold of the snake, with an antidote composed of pounded herbs, the virtue of which is such, that they hold with the naked hand, and provoke fearlessly, the deadly cobra di capello. The secret is not unknown in China; and the cobra, in common with other serpents of a similar nature, are often exhibited in Canton.

Why are vipers distinguished from snakes?

Because vipers bring forth their young alive, whereas, snakes hatch their young from eggs, in dunghills, &c.

THE RATTLESNAKE.

Why is the rattle-snake so called?

Because it has a series of cups appended to its tail; which cups, when the serpent moves its body, likewise move one upon another, and make a rattling noise, not unlike the folding of dried parchment. This noise is said to be audible at the distance of twenty yards, and is thus useful in giving warning of the approach of the destructive reptile, to which it is attached. Its bite is attended with frightful consequences, as in the following instance:—"An emigrant family inadvertently fixed their cabin on the shelving declivity of a ledge, that proved a den of rattle-snakes. Warmed by the fire on the hearth of the cabin, the terrible reptiles entered in numbers, and, of course, in rage, by night, into the room where the whole family slept. As happens in those cases, some slept on the floor, and some in beds. The reptiles spread in every part of the room, and mounted on every bed. Children were stung in the arms of their parents, and in each other's arms. Most of the family were bitten to death; and those who escaped, finding the whole cabin occupied by these horrid tenants, hissing and shaking their rattles, fled from the house by beating off the covering of the roof, and escaping in that direction."—*Flint's Geography and History of the United States.*

Dr. Mead supposes this rattle may serve to bring birds, &c., within the reach of the snakes, from the effect its sound produces. Major Gardner, who had lived long in East Florida, affirms, that the young Indians of that country, were accustomed to imitate the noise of the rattle-snake, for the purpose of taking squirrels, &c.

Blumenbach says, "we are assured, by credible eye-witnesses, that squirrels, small birds, &c. fall from the trees on which they stand, into the throat of the rattle-snake below; the circumstance is not, however, by any means confined to this genus, as it has been remarked in many other serpents of both the Old and the New World. Rattle-snakes are eaten by hogs and birds of prey. They may also be tamed, and rendered docile."

Why is the rattle-snake inaudible in the wet season?

Because, as the cups of the rattle consist merely of dried matter, which, in the dry season, is brought into a condition to make a noise when the animal moves, so, in like manner, the rattle, in the wet season, is soft and mute.

THE SEA-SERPENT.

Why is the existence of the American sea-serpent no longer credited?

Because of the following exposure of its fraud, as related by Professor Silliman.

The first sea-serpent was a steam-boat, which, being established at Boston to coast along the shore, and from its powers and capabilities competent to injure the business of small boats, was described as a sea-serpent that had been seen off Nahant and Gloucester, and had probably come there to consume all the small fish in the place. This was received by many as a serious account, and believed accordingly.—Another sea-serpent history arose from the circumstance, that a small sloop, called the Sea-serpent, having been passed by

another vessel, the captain of the latter, when asked, upon his arrival at home, for news, said he had seen a sea-serpent, and then described its bunches on the back, the action of its tail, and other parts; all of which being understood literally, actually appeared in print, as evidence for the existence of the animal.

Then a piece of the skin of the bony scaled pike was taken for part of a sea-serpent's hide. And from such occurrences as these, perhaps, mingled with careless observation of the motions and appearances of porpuses, basking sharks, and balænopterous whales, appear to have originated every thing that has been said about American sea-serpents.

Dr. Fleming thinks it "probable, that many of those stories which have been propagated, regarding *vast sea-snakes*, have originated in the appearance of some of the larger serpents at sea, where they have been driven by accident. Some of the Asiatic species reside almost constantly in the water, either fresh or salt."

In 1827, Dr. Harwood presented to the Royal Society an account of a new serpentiform sea animal, which he named the *ophiognathus*. The specimen is 4 feet 6 inches in length, and the jaws open wider than those of any other animal that the Doctor is acquainted with; not excepting even the rattle-snake. Its entire form indicates that it must possess great swiftness of motion in the waters.

FISHES.

GENERAL ECONOMY.

Why does swimming resemble flying?

Because the organs which are employed for both purposes, resemble the oars of a boat in their mode of action; and, in general, possess a considerable extent of surface and freedom of motion. The former condition enables them to strike the surrounding fluid with an oar of sufficient breadth, to give progressive motion to

the body; and the latter permits the same organ to be brought back to its former position for giving a second stroke, but in a different direction, and without offering so great a resistance. The centre of gravity is so placed, that the body, when in action, shall rest on the oars or swimmers, or be brought by certain means to be of the same specific gravity with the water.

Why do fish swim?

Because they have fins, which balance and keep them level; and tails, which act against the water, and direct them like rudders.

The form of the body in fishes, is infinitely more varied than in reptiles or serpents. In most, however the body has a vertical direction, *i. e.* flattened at both sides; in some, on the contrary, as the rays, it is horizontal, and extended laterally; in others, as the eel, &c., it is more rounded; in some prismatic, or quadrangular. In all, the head and trunk are connected immediately, without being separated by a neck.—*Blumenbach.*

Why are the fisheries of Britain so important a portion of her resources?

Because her limited soil, contrasted with extensive sea-coasts, and numerous rivers and lakes, intimate to her population, the expediency of obtaining a large portion of their sustenance from the waters. These are known to teem with life, and to furnish a supply of agreeable and nourishing food, which may be pronounced inexhaustible.

Savage nations, as the Kamschatkadales, Brazilians, &c. possess the art of preparing fish in a great variety of ways, even as a kind of flour, bread, &c. With many, as the Islanders of the Pacific Ocean, fishing forms a principal occupation, and a serious kind of study with reference to the ingenious methods and instruments which they have invented. To a great part of the cultivated world, the taking of the herring, cod,

tunny, &c. is of still greater value. The oil of the shark, cod, and herring, is used for burning in lamps, &c. The inhabitants of the eastern coast of the middle of Asia, clothe themselves with the tanned skin of the salmon. Many parts of other fish are employed for the purposes of art, as the scales of the bleak, for making false pearls. Shagreen is made from the skins of sharks and rays.

Why do fishes die almost immediately in the air?

Because asphyxia (or suspension of pulsation) is occasioned by the sinking of the branchiæ, or gills, no longer supported by the interposition of water between their laminæ (or layers); and this idea has been confirmed in prolonging the life of fishes, by artificially keeping the laminæ in the state of separation which the water produces. On the other hand, by compressing the branchiæ under water, similarly to their condition in the air, death occurred as quickly as in the latter fluid.

Water may act on the respiration of fishes chemically, physically, or mechanically. The latter influence has, however, been but imperfectly attended to. In 1830, M. Fleurens, with the view that water exercises only a mechanical action on their respiration, put several fish into wine. They did not live as in water, but their death was much longer delayed than in air. He explained this action of the wine, by remarking that this liquid contains much less air than water.

Why do fishes, when dead, float on the surface of the water, with the belly uppermost?

Because the body being no longer balanced by the fins of the belly, the broad muscu ar back preponderates by its own gravity, and turns the belly uppermost, as lighter, from its being a cavity, and because it contains the swimming bladders, which continue to render it buoyant.—*White's Natural History of Selborne.*

Why have not fishes any voice?

Because they have not lungs.

Although fishes possess no voice by which they can communicate their sensations to others, some species utter sounds when raised above the water, by expelling the air through the gill-opening when the flap is nearly closed: while others, even under water, as the salmon, utter certain sounds while depositing their spawn; but for what purpose these sounds are uttered, or by what organs they are produced, we are still ignorant. —*Fleming.*

A writer in the *Magazine of Natural History* tells us, that some tench which he caught in ponds, made a croaking like a frog for full half an hour, whilst in the basket at his shoulder.

Why are fishes said to have "true" fins and gills?

Because these organs may be distinguished from others to a certain degree analogous in young frogs, &c. The gills are filled with innumerable very delicate vessels, and are mostly divided on each side into four layers, which somewhat resemble the beard of a quill, and which are attached at their basis to a corresponding number of little bones.—*Blumenbach.*

Why are these fins essential to swimming?

Because they consist of jointed rays, covered by the common integuments: these rays serve to support the fishes, and approach or separate like the sticks of a fan, and move upon some more solid body as a fulcrum. Thus, in sharks, the rays of the fins behind the gill are connected by a cartilage to the spine.

The motions of fish are indeed performed by means of their fins. The caudal, or tail fin, is the principal organ of progressive motion; by means of its various flexures and extensions, it strikes the water in different directions, but all having a tendency to push the fish forward; the action resembling, in its manner and effects, the well known operation of the sailor termed

skulling. The ventral and pectoral fins assist the fish in correcting the errors of its progressive motions, and in maintaining the body steady in its position. Borelli cut off, with a pair of scissors, both the pectoral and ventral fins of fishes, and found, in consequence, that all the motions were unsteady, and that they reeled from right to left, and up and down, in a very irregular manner.

Why are the fins of fishes important to the naturalist?

Because the characters furnished by their position, are employed as the basis of his classification. Thus, by Linnæus and others, the ventral or belly fins, are considered as analogous to the feet of quadrupeds, &c.

Why do medusæ swim, although they have no fins, or oars?

Because they vary the form of the body by alternate contractile and expansive movements.

We may here observe, that the motions in water caused by sea animals of various descriptions, were noticed at an early period by observers, but it is only of late years that they have engaged the particular attention of zoologists.

Why have fishes such extraordinary number and bulk of muscles?

Because they may support that great expenditure and exertion, which is a necessary consequence of the peculiar abode, and whole economy of these animals. —*Blumenbach.*

Why have fishes gills?

Because they are calculated to separate air from water, with which it is always united, and bring it into contact with the blood. It is to be observed, however, that many animals which reside in the water, breathe by means of lungs, and are obliged, at intervals, to come to the surface to respire, such as whales; but there are no animals which reside on the land, and

are furnished with gills, which are obliged to return to the water to respire.—*Fleming.*

Why do those fishes, in which the gill openings are but imperfectly covered, expire soonest when taken from the water?

Because the air soon dries the fine plumes of the gills, and obstructs the process of respiration and circulation.

Why does respiration by gills differ from that by lungs?

Because the former, as in fishes, introduces the air, which the water holds in solution, through the mouth into the gills, and then expels it again through the branchial aperture; consequently, not by inspiring and expiring through the same passage, as in those animals which possess lungs.—*Blumenbach.*

Why do some fishermen cut the gills with a knife as soon as the fish is taken?

Because an injury received by the gills of fishes is attended by a considerable effusion of blood; and a fish so killed, will keep much longer in a fresh state, than one on which this operation of bleeding has not been performed.

Why is the surface of the skin of fishes almost always covered with slimy fluid?

Because it may protect them from the penetrating influence of the surrounding element.

The pores from which this viscous matter is secreted, are frequently visible to the eye in fishes: they are connected with vessels which traverse the body under the skin, and contain the fluid.—*Fleming.*

Why are the scales, or rather hard coverings, of such protection to reptiles and fishes?

Because these parts possess neither vessels nor nerves; and, therefore, the whole superficies of the animal's body is insensible, and constitutes a dead medium,

through which impressions are conveyed to the subjacent living parts.—*Blumenbach.*

Why do the scales of fishes differ from hair and feathers?

Because scales are not changed, but are perennial; and are said to receive yearly an additional layer, from the number of which the age of the animal may consequently be determined. The scales of sea-water fish are bare, but those on coasts or in fresh water are covered with a mucous or slimy membrane.

In examining these different appendices of the skin, we perceive that they pass, by insensible degrees, into one another, as hair into spines, horns into nails, scales into shells, and crusts into membranes. They have all one common origin, namely, the skin; and, independent of secondary purposes, they all serve for protection.—*Fleming.*

Why is the gullet remarkably short in fishes?

Because they have no neck. In some, indeed, the stomach seems to open directly into the mouth. The gullet is, however, capable of great extension, and when the stomach is unable to hold the whole of the prey, which has been seized, a part remains in the gullet until the inferior portion gives way.—*Fleming.*

Why is the air-bag or sound considered an article of value?

Because this organ in the cod or ling, when salted, forms nourishing and palatable food. But it is chiefly in the manufacture of isinglass, that the sounds of fishes are extensively employed. Sturgeon sounds are chiefly used for this purpose.

When in a sound state, the external skin of the air-bag (regarded as possessing strong muscular power) is supposed capable of contraction, so as to condense the air, and enable the animal to sink; or of extension, so as to allow the air to expand, and aid the animal in rising in the water.

Why is isinglass so nutritious?

Because it consists almost entirely of gelatine.

Why is the air-bladder thought to be unconnected with the respiration of fishes?

Because this bladder does not exist in many fishes.

Why is the air-bladder believed to be subservient to the motion of fishes?

Because it is largest in such fishes as swim with considerable velocity.

Why have flat fish large lateral fins?

Because they have no air-bladder to enable them to swim. In the shark the absence of the air-bladder is compensated by the size and strength of the tail.

Why does the lamprey creep slowly at the bottom of the water?

Because it has neither air-bladder nor fins to enable it to swim.

Why is the osteology of fishes but little attended to by naturalists?

Because the skeleton is more complicated than that of man, and is difficult to prepare and preserve.—*Fleming.*

The bones of fishes, when reduced to powder, are mixed up with farinaceous substances, and used instead of bread, by some of the northern nations.

Why do fishes leap?

Because of a violent effort of the caudal fin; or, according to some, by bending the body strongly, and afterwards unbending it with an elastic spring.

Why are certain fish enabled to fly?

Because they have the air-bag of uncommonly large dimensions, wherefore the body has great buoyancy. The pectoral fins are likewise large, and having, by a leap raised themselves above the surface of the water, they continue in the air and move forwards, seldom farther than a hundred yards, by the action of these fins.

Why cannot these fish take long flights?

Because the membrane of their fins soon becomes dry, when they again fall into the water. The flying fish generally leave the water to escape from other fish which prey upon them.

There is also a species of fish which is capable of *climbing*, and has been known to raise itself five feet above the surface of the water, and mount up the crevices of trees, by means of its various spines.

Why have some fish a sucker?

Because, it is supposed, by its means the fish attaches itself to the sides of other fishes, or to the bottoms of ships, when it is carried forward without any exertion of its own; and, during storms, adhesion to rocks may save a weak fish from being tossed about by the fury of the waves: other purposes, probably, remain to be discovered.

About five years since, a correspondent of the *Quarterly Journal of Science*, drew up, in Dublin harbour, a whiting pollack, under whose throat a sea-lamprey had buried its head, and thus firmly attached itself. When separated, the lamprey darted on its prey, to which it again adhered firmly.

Why is the eye one of the most important organs which fishes are known to possess?

Because it enables them to perceive the approach of their foes, and it is the principal instrument by which they obtain their food. The amateur in fly-fishing often tempts the fish with one kind of fly, but in vain; and, upon substituting another in its place, of a different form or colour, succeeds in the capture. These motions of fish are all regulated by the eye: hence some fish will bite as readily at a bit of red cloth as at a piece of flesh.—*Fleming*.

The eyes of fishes are larger in proportion to the size of their bodies, than in quadrupeds, as we find the eye of the cod-fish equal in size to that of an ox.

Why have the ray and shark such extraordinary strength of sight?

Because the eye rests on a thin cartilaginous pulley, which is attached to the bottom of the orbit, and thus increases its motions. In other fishes, the motions of the eye are confined.

Why do not fish sleep?

Because they have no eye-lids, nor any membrane to close and cover their eyes, as animals that sleep have.

Why is the internal ear of fishes distinguished from that of the other three classes of red-blooded animals?

Because it grows as the fish increases in size, and consequently its magnitude is in the direct ratio of the bulk and age of the animal.

Why are fishes supposed to possess a feeling analogous to the sense of touch?

Because most of them feel acutely on the abdomen, and in the lips. It is doubtful whether their tongue be an organ of taste, and in what degree it may serve that purpose.—*Blumenbach.*

Why is the reproduction of fishes so enormous?

Because, probably, a great number of species live in succession on each other, according to their strength and voracity.

The following may convey some idea of the prolific powers of fish:—

		Eggs.
Carp	produces	203,109
Cod-fish		3686,760
Flounder		1357,400
Herring		36,960
Mackerel		546,681
Perch		28,323
Pike		49,304
Roach		81,586
Smelt		38,278
Sole		100,362
Tench		383,252

The rays and sharks seem to produce but a very limited number. The utmost, stated by different ob-

servers, is 26 and 30. It should be added, that there is no estimated proportion between the number of eggs deposited, and the number of fish which arrive at maturity. The eggs are eagerly sought after by other fishes, by aquatic birds, and reptiles; and in the young state, they are pursued by their own species, as well as by beings belonging to other classes.

Why do fishes materially increase in size, previous to the approach of the spawning season?

Because they may be the better enabled to undergo the fatigues and fastings by which spawning is accompanied. The muscles then acquire size and strength, especially those connected with the tail, the principal organ of progressive motion, so that the body behind appears plump and round. A great deal of fat is deposited between the muscles, but especially on the belly, the flesh of which is, at this time, of considerable thickness.

Why does this fatness decrease, as the spawn advances to maturity?

Because the fat is withdrawn for its nourishment; the belly becomes little else than skin, and while the deluded epicure, upon seeing the large roe, imagines that his fish is in the best condition, it has actually reached the very maximum of worthlessness. When the business of spawning is over, the leanness of the fish then becomes apparent, and the extraordinary muscular exertion which it has undergone, is marked by the leanness of its head and the lankness of its tail.

Why do fishes deposit the spawn towards the margin of a river, &c.?

Because in the shallow water the numerous small animals reside, which constitute the most suitable food for the tender fry.

Again, the cod and haddock, the mackerel and herring, annually leave the deeper and less accessible parts of the ocean, the region of the zoophytic tribe,

and deposit their spawn within that zone of marine vegetation which fringes our coasts, extending from near the high-water mark of neap-tides, to a short distance beyond the low-water mark of spring-tides. Amidst the shelter in this region, afforded by the groves of arborescent fuci, the young fish were wont, in comfort, to spend their infancy; but since these plants have been so frequently cut down to procure materials for the manufacture of kelp, and the requisite protection withdrawn, the fisheries have suffered in consequence.

Why are fishes caught by baits?

Because they are deceived by analogy, considering the identity as perfect, when there are only a few points of resemblance.—*Fleming.*

We may observe, that the well-known voraciousness of fishes, the eagerness with which they seize a metal button, or any glittering object—the whole art of artificial bait and fly-fishing, all seem to point out the organ of sight, as the principal instrument by which they discover their food.

Why do anglers maintain that fly-fishing is not a species of cruelty?

Because the hook is usually fixed in the cartilaginous part of the mouth, where there are no nerves; and a proof that the sufferings of a hooked fish cannot be great, is found in the circumstance, that though a trout has been hooked and played for some minutes, he will often, after his escape with the artificial fly in his mouth, take the natural fly, and feed as if nothing had happened; having, apparently, learnt from the experiment, that the artificial fly is not the proper food. Pikes have been caught with four or five hooks in their mouths—and tackle which they had broken only a few minutes before.—*Sir H. Davy, in "Salmonia, or Days on Fly-fishing."*

Why are anglers recommended to fish early and late in the summer months?

Because, generally, fish do not then feed in the middle of the day, unless the weather be very dark and gloomy—during drizzling rain—or a light breeze of wind.

Why are fishes considered nocturnal animals?

Because they are active during the night, and in the day remain in a state of repose. Hence the inhabitants of islands and coasts, who live on fish, choose the night for catching them.—*Blumenbach.*

Why are some fishes said to be amphibious?

Because they are capable of living either in fresh or salt water at pleasure. Such fish, in an economical point of view, are extremely valuable, as they furnish to the inhabitants of this and other countries, an immense supply of food. The salmon is an instance in Scotland, where from one river, (Tay) 50,000 head of full-sized fish have been procured in one season. To the Greenlanders, their salmon is, perhaps, more valuable; as it is dried hard, then broken and pounded, and formed into bread,—as well as consumed in a fresh or salted state.

Why are fishes generally supposed to attain a great age?

Because the element in which they reside, preserves them from the pernicious influence of sudden changes of temperature: the process of ossification, (or growth of bones) is very slow in them; their blood is very cold—and their primary movements tardy. Accordingly, we find the age of the carp has been known to reach 200 years, and the pike to 260. "The marks, however, by which the age of fishes may be determined, remain to be discovered."—*Fleming.*

Why does a fish but seldom die a natural death from old age?

Because, during every period of its existence, it is surrounded by foes; and when no longer able to exercise its wonted watchfulness, or exert its power of defence, it falls an easy prey to its more powerful adversaries.

Why are not fishes found in all rivers in mountains?

Because they appear to prefer certain altitudes. Thus, in ascending mountains, we may observe, that the fish in the lakes and rivers have their boundaries, as well as the vegetables which cover their surface. Wahlenberg found that the pike and perch disappeared from the rivers of the Lapland Alps, along with spruce fir, and when 3,200 feet below the line of perpetual snow. Ascending 200 feet higher, the gwiniad and the grayling, were no longer to be found in the lakes. Higher up still, or about 2,000 feet below the line of perpetual snow, the char had disappeared; and beyond this boundary, all fishing ceased.

Why is fish oil (of the sprat, pilchard, &c.) very liable to become fœtid?

Because, in general, the oil is obtained from the livers of the fish, in which it is lodged in cells; but, as it cannot be procured completely from livers by mere boiling, they are allowed to become a little putrid, that the oil may be more readily extracted, by the rupturing of the cells. Along with the oil various other impurities are obtained, as bile, gelatinous matter, &c.

Why have so many absurd stories been told of showers of fishes?

Because it sometimes happens that vivacious fishes, or those capable of surviving a long time out of water, are conveyed to a distance by birds, and left without being killed, on rocks or fields.—*Fleming.*

Why are some kinds of fish poisonous?

Because of the quality of the food on which they have subsisted. This is only conjecture, but is supported by the history of the mussel and the oyster,

which owe their occasional noxious qualities to the zoophytes on which they feed.

The poisonous qualities of some shell-fish are, however, attributed by writers on their dietetic properties, to other causes, as we have already shown.*

Why are sea fish sometimes found in fresh water?

Because, in forsaking the deep water, and approaching a suitable spawning station, they leave the sea altogether for a time, ascend the rivers and their tributary streams, and having deposited their eggs, return again to their usual haunts. Even certain species of fish, inhabiting lakes, as the roach, betake themselves to the tributary streams, as the most suitable places for spawning.

Why, in stocking fish-ponds, should the transportation of fish take place only in winter?

Because fish can bear cold much better than heat.

Why are fish, as an article of food, well suited for the young, the weak, and the sedentary?

Because it is light, and easily digested; but, for the same reason, it is unsuitable food for those engaged in laborious occupations.

Why is it difficult to preserve fish in glass jars, or small ponds?

Because a great deal of the oxygen in the air contained in the water, is necessarily consumed by the germination and growth of the aquatic plants, and the respiration of the infusory animalculæ. In all cases, when the air of the atmosphere, or that which the water contains, is impregnated with noxious particles, many individuals of a particular species, living in the same district, suffer at the same time.

Why do fishes perish in water that has been boiled?

Because the water is then deprived of its atmospheric air, by means of which fishes carry on their respiration.

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* See DOMESTIC SCIENCE, page 45.

Why, when fish are steeped in water, does the whole fluid become luminous?

Because the luminousness appears to be caused by the infusory animalculæ, with which water abounds. —*Canton, Phil. Trans.*

Why are fish said to be "in season"?

Because the milt and roe are then ripening. After the fish have deposited the spawn, the flesh becomes soft, and loses much of its peculiar flavour. This is owing to the disappearance of the oil or fat from the flesh, it having been expended in the function of reproduction.

When in season, the thick muscular part of the backs, as it contains the smallest quantity of oil, is inferior in flavour or richness, to the thinner parts about the belly, which are esteemed by epicures, as the most savoury morsels.

Why is the reproduction of fishes involved in great obscurity?

Because the element in which they reside conceals from us the actions which they perform, so that we are unable to point out, with certainty, the uses of the different organs, or the functions which they exercise. Even in the days of Aristotle, the difference in the mode of reproduction between the cartilaginous and the osseous fishes had been observed; and although many accurate observations have been made by modern zootomists, much still remains to be done, both in the field of observation and dissection.

In reference to the reproductive system, fishes may be divided into two classes. Thus, some have the sexes distinct, while in others they are united.—*Fleming.*

RAY-FISH.

Why do the ray genus appear to have contributed to the fable of Sirens?

Because of a certain similarity of the lower part of their head to the human face. Many species have

also been dried, and metamorphosed by a variety of artifices, into supposed basilisks, &c. Although they lay but one egg at a time, they increase so rapidly, that the ocean, in some spots, actually swarms with them. Their eggs have a horny covering with four points, and are called sea-mice.—*Blumenbach.*

Why is the liver of the skate, cod, and some other fishes, remarkably oily?

Because the rest of their bodies is almost destitute of fat.

Dr. Monro, calculated that the whole gills of a large skate, presented a surface equal to 2,250 square inches; or equal to the whole external surface of the human body.

SHARKS.

Why have most of the sharks very numerous teeth?

Because they may supply such as may be lost. The white shark has more than 200, lying on each other in rows, almost like the leaves of an artichoke. Those only, which form the front row, have a perpendicular direction, and are completely uncovered. Those of the subsequent rows are, on the contrary, smaller; have their points turned backwards, and are covered with a kind of gum. These come through the covering substance, and pass forward when any of the front row are lost. The teeth are at first soft and cartilaginous, but gradually become hard as ivory.

The white shark weighs as much as 10,000 pounds, and even whole horses have been found in its stomach. —*Blumenbach.*

Voracious as are the habits of sharks, the South Sea islanders are not in the least afraid of them. Portlock, the navigator, says: "I have seen five or six large sharks swimming about the ship, where there have been upwards of 100 Indians in the water: they seemed quite indifferent to them, and the sharks never offered to make an attack on any of these people, and

yet at the same time, they would greedily swallow our baits." The perseverance with which sharks follow a vessel at sea, containing a dead body, would prove their nasal organs to be very acute. In a recent voyage from Bombay to the Persian Gulf, the smell of a dead body of an Arab sailor of a crew, attracted several sharks round the ship, one of which, eight feet in length, was harpooned and hauled on board.

As a curious fact connected with the natural history of the Bible, we may mention that, in 1828, the Rev. Dr. Scot, of Corstorphine, read before the Wernerian Society, a paper on the great fish that swallowed up Jonah, showing, that it could not be *a whale*, as often supposed, but was, probably, *a white shark.* We may observe, that the *whale* is a gratuitous identity, since the text is " a great fish."—(*Jonah*, *c.* ii. *v.* 7.)

Why is the hammer-headed shark also called the balance fish.

Because it has a long obtuse head with eyes fixed at the extremities, and its mouth in the centre. Unlike other sharks, the above is more remarkable for its structure than size, it being little more than 6 feet in length.

Why is the pilot-fish so called?

Because it is always found accompanying or preceding the formidable shark.

Why is the saw-fish so called?

Because it has a broad, sword-like weapon in front of the head, with twenty-four or more teeth inserted into its lateral edges.

Why is the sturgeon said to have given rise to the fabulous tales of monstrous sea-serpents of the North?

Because it often happens that many of them follow in a row one after another. The sturgeon is an important fish—as well for its flesh, as for the caviare prepared from its roe. It sometimes weighs nearly 1,000 pounds.—*Blumenbach.*

Why is the sun-fish so called?

Because of the phosphorescent light of the sides and belly of the living fish. It weighs, occasionally, as much as five cwt.

Why was the sucking-fish formerly believed able to stop a ship in full sail?

Because it can attach itself most firmly, by means of the grooves on the back part of its head, to ships, sharks, &c.

Why is a certain fish called the sea-horse?

Because of the resemblance of its front part to a horse's head and neck. In dying, it bends itself like an S; and then resembles the knight, at chess.

Why is the sea-dragon so called?

Because it has large and wide pectoral fins, which resemble expanded wings.

EELS.

Why has the economy of the eel so long exercised the ingenuity of naturalists?

Because they have hitherto been unable to establish their mode of generation. Lacepède, the French naturalist, asserts, in the most unqualified way, that they are viviparous; but, says Sir H. Davy, "we do not remember any facts brought forward on the subject." Blumenbach says—"According to the most correct observations, the eel is certainly viviparous;" for which he quotes Voight's *Neues Magazine.* Sir Everard Home, by a course of patient investigation, has ascertained that the common and conger eels, as well as lampreys, are hermaphrodites.

Why do young eels seek fresh water?

Because they prefer warmth, and swimming at the surface in the early summer, find the lighter water warmer, and likewise containing more insects, and so pursue courses of fresh water,—as the waters from the

land, at this season, become warmer than those from the sea.

Sir H. Davy, in his *Salmonia*, has some interesting observations on this curious subject:—"Thus, it is certain, that there are two migrations of eels—one up and one down rivers, one *from* and the other *to* the sea; the first in spring and summer, the second in autumn, or early in winter. The first of very small eels, which are sometimes not more than two or two and a half inches long; the second of large eels, which sometimes are three or four feet long, and which weigh from 10 to 15, or even 20 lbs. There is great reason to believe, that all eels found in fresh water, are the results of the first migration; they appear in millions in April and May, and sometimes continue to rise as late even as July, and the beginning of August. I remember this was the case in Ireland in 1823. It had been a cold, backward summer; and when I was at Ballyshannon, about the end of July, the mouth of the river, which had been in flood all this month, under the fall, was blackened by millions of little eels, about as long as the finger, which were constantly urging their way up the moist rocks by the side of the fall. Thousands died; but, their bodies remaining moist, served as the ladder for others to make their way; and I saw some ascending even perpendicular stones, making their road through wet moss, or adhering to some eels that had died in the attempt.—Mr. J. Couch, in the *Linnæan Transactions*, says, the little eels, according to his observation, are produced within reach of the tide, and climb round falls to reach fresh water from the sea. I have sometimes seen them in spring, swimming in immense shoals in the Atlantic, in Mount Bay, making their way to small brooks and rivers. When the cold water from the autumnal flood begins to swell the rivers, this fish tries to return to the sea; but numbers of the smaller ones hide themselves during the winter in the mud, and many of them form, as

it were, masses together. Dr. Plot, in his *History of Staffordshire*, says: "eels pass in the night across meadows, from one pond to another;" and Mr. Anderson, in the *Philosophical Transactions*, distinctly states, that small eels have risen up the flood-gates and posts of the water-works of Norwich; and then made their way to the water above, though the boards were smooth-planed, and 5 or 6 feet perpendicular. He says, when they first rose out of the water upon the dry board, they rested a little, which seemed to be till their slime was thrown out, and sufficiently glutinous; and then they rose up the perpendicular ascent, with the same facility, as if they had been moving on a plane surface. There can, I think, be no doubt that they are assisted by their small scales, which, placed like those of serpents, must facilitate their progressive motion; these scales have been microscopically observed by Leuwenhoeck."

Why is it probable that common eels are often confounded with the conger?

Because, as very large eels, after having migrated, never return to the river again, they must, (for it cannot be supposed that they all die immediately in the sea) remain in salt water. The conger eel, it may be added, is found from a few ounces to 100 lb. in weight.

Why is the eel destitute of ventral or belly fins?

Because its form is so entirely equal as to require little balance either one way or the other; the use of the ven.ral fins being to balance the fish in the water.

Why may an eel be skinned without producing any hole in the situation of the eye?

Because the skin in this and the greater number of fishes, passes directly over the eye without forming any fold; and in the above case it does not adhere very closely to the eye; the skin only exhibiting at that place a round transparent spot.

Why are some fishes blind?

Because of the uniform opacity of the skin in passing over the eye.

Why does the skin of the eel turn white when plunged into boiling water?

Because of the coagulation of the albumen in which the skin is enveloped.

ELECTRICAL FISH.

Why is not a benumbing sensation always felt when these fish are touched?

Because the animal appears only to excite it when irritated or otherwise disturbed. Then the fish is observed to twist its body, as if about to make a vigorous muscular exertion; and a benumbing sensation is instantly felt in the fingers, and even as far as the elbows. The fish is capable of making this benumbing effort many times in succession in the water, as well as in the air, when arrived at maturity, and even previous to the natural period of exclusion from the uterus of the mother. When caught in the net, it gives a shock to the hands of the incautious fisherman, who ventures to seize it. When concealed in the mud, it is capable of making its most violent efforts; and is able to benumb the limbs to such a degree, as to throw down the passenger who inadvertently places his foot upon the body.

We have already noticed the electrical organs of fishes in connexion with the Voltaic apparatus.* Their *structure* should be more specially mentioned here, although, to explain this fully would occupy more space than we can devote to the subject, great as is its naturo-philosophical interest.—The organs of the *torpedo* (of the ray tribe) are double, and occur in the fore part of the body, one on each side of the cranium, and extend back as far as the gill-openings, occupying the whole skin between the upper and under surfaces.

* See POPULAR CHEMISTRY, pp. 46 and 47, Part V

In the *gymnotus electricus*, (or electric eel) the organs occupy scarcely one half of the body of the animal, being two on each side, and extending along the sides and belly, from the head to near the tail. In the *silurus electricus*, found in African rivers, the structure of the organ is more simple than in the torpedo or gymnotus. It consists of a bed of very fine meshes, which cross each other in every direction, the whole being covered by a membrane, which is itself covered with a layer of fat. The nerves with which the organ is provided, proceed from the eighth pair; but are not so large in proportion as in the torpedo.—*Abridged from Fleming's Philosophy of Zoology*, vol. i.

THE DORY.

Why is the fish dorée so called?

Because, while living, the colour is very resplendent, and as if *d'orée*, or gilt; but Sir Joseph Banks used to say it should be *adorée*, and that it was the most valuable of fish because it required no sauce.

Why is the John Dory in Venice called the Janitore, or the gate-keeper?

Because St. Peter is most commonly designated, among the Catholics, as being the reputed keeper of the keys of heaven; and out of the mouth of this fish they believe the Apostle took the tribute money.

Why do some Catholics believe the John Dory to be the fish out of whose mouth St. Peter took the tribute money?

Because the breast of the fish is very much flattened, as if it had been compressed; but, unfortunately for the credit of the monks, this feature is exhibited by at least twenty other varieties of fish.

THE PERCH, ETC.

Why is the perch better armed against the attacks of its enemies than most fresh-water fishes?

Because its spines, when it attains any considerable

size, protect it from the voracity of other fishes; and when full-grown, even the pike dares not attack it, though the very young perches are its favourite food. Salamanders, small vipers, and young frogs, serve as food to the perch; and M. de Lacepède has assured Baron Cuvier that they seize even young water-rats.

Several species of water-birds, however, pursue the perch with great avidity. It fears thunder, is afraid of frost and ice, and has internal enemies in intestinal worms; of which, according to Rudolphi, no less than seven species are found in the body of the perch. This fish is very tenacious of life, and Pennant asserts that it may be carried in dry straw for sixty miles without much danger.—*Cuvier.*

Why is the stickleback so fatal to the perch?

Because the former often erects its sharp dorsal spines at the moment the perch is about to swallow it, which stick in the palate or throat.—*Cuvier.*

THE MULLET.

Why were large red mullets so highly prized by the Roman epicures?

Because they were more difficult to be got; not that the larger fish were more delicate. Juvenal says,

> The lavish slave
> Six thousand pieces for a mullet gave
> A sesterce for each pound.

—But Apicius gave 8000 *nummi*, or 64*l.* 11*s.* 8*d.* for a fish of as small a size as a mullet.

SALMON.

Why do salmon, which begin to approach the coast and enter the rivers as stragglers about February, increase in numbers towards May and June?

Because the drought and heat of summer render the *streams* unfit for their reception. At this period they crowd, in shoals, towards the coast, and roam about the estuaries, until the autumnal floods again entice them to enter the rivers.

Why do salmon spawn in the shallow gravelly fords at the top and bottom of pools?

Because they there make a bed by the parent fish working up against the stream, the spawn being deposited in the gravel and covered at the same time. The bed sometimes reaches from twelve feet in length to ten in breadth. The process frequently occupies more than a week; during which the eggs deposited by a single fish sometimes amount to 20,000. This spawning season extends from the end of October to the beginning of February, and, according to very satisfactory evidence, it occurs about the same time throughout all the rivers of the United Kingdom. The eggs of the salmon remain in the gravel for several months, exposed to the influence of running water. In the course of the month of March, and nearly about the same period in all our rivers, the fry are evolved. When newly hatched, they are scarcely an inch in length, of the most delicate structure, and for awhile connected with the egg. Upon leaving the spawning bed, the fry betake themselves to the neighbouring pools, where they speedily increase to two or three inches in length. In April, May, and June, they migrate towards the sea, keeping near the margin, or still water, in the river, and when they reach the estuary, they betake themselves to a deeper and more sheltered course, and escape to the unknown haunts of their race, to return shortly after as grisles, along with the more aged individuals. All these seaward migrations of the parent fish and the fry, are influenced and greatly accelerated by the occurrence of the floods in the rivers.—*Quarterly Review.*

Why do salmon rise better at the fly when the tide is rising, than when it is falling?

Because the turn of the salt water brings up aquatic insects, and perhaps small fish; and it is supposed that salmon know this, and search for food at a time when it is likely to be found.—*Salmonia.*

Why are certain rivers "fenced," or the fishing of salmon prohibited during some months of the year?

Because the breeding fish and the helpless fry may be preserved and protected.

Why is the par or samlet also called the finger-ling?

Because it has large blue or olive bluish marks on the sides, as if they had been made by the impression of the *fingers* of a hand.

Why do the smallest trouts spawn nearly at the same time with the larger ones?

Because, in the physical constitution of these animals, their production is diminished as their food is small in quantity. The ova of the large and small trouts are of the same size; but in the large trout there are tens of thousands, and in the small one rarely as many as forty.

Trouts vary in size, from the great lake trout, weighing above 60lb. or 70lb. to that of the brook, which is scarcely larger than the finger.

Why are there supposed to be so many varieties of sea-trout?

Because fresh-water trout are sometimes carried in floods to the sea, and come back larger and altered in color and form, and are then mistaken for new species; and as each river possesses a variety belonging to it, this, with differences depending upon food and size, will, it is thought, account for the peculiarities of particular fish, without the necessity of supposing them distinct species. The same holds good with regard to salmon.—*Salmonia.*

THE GRAYLING.

Why was the grayling called by St. Ambrose, "the flower of fishes?"

Because of its agreeable odour, and brilliant colours. A fine specimen is thus described:—"The belly is silvery, with yellow; and the pectoral, ventral, and anal fins, are almost gold-coloured; the back gray,

with small black spots; and the black fin beautifully coloured bright purple, with black and blue spots." In flavour, the grayling is "like the most exquisitely tasted of all our fish, the red mullet."

The grayling is supposed to have been introduced by the monks, in the time when England was under the See of Rome, from the rivers that contain it being near the ruins of great monasteries. Thus, the Avon, near Salisbury; the Ure, near Fountain's Abbey; the Wye, near the great abbey of Tintern, &c. There are, however, rivers so situated, wherein the grayling is not found; for instance, in the Stour, at Canterbury.

THE PIKE.

Why is the pike considered one of the most voracious of fishes?

Because it devours not only fish, but also amphibia of all kinds, toads, &c.; many aquatic birds, small quadrupeds, and even crabs.

Stones, weighing 5 oz. and upwards, have sometimes been found in the stomachs of pikes, which must have been swallowed by them whole.

The Zetlandic fishermen assert, that cod-fish swallow stones before a storm, to enable them to rest more securely at the bottom of the sea, during the continuance of the agitated waves.—*Fleming*.

THE HERRING, BARBEL, ETC.

Why is the herring a most important animal in the northern world?

Because, though attacked by man, and many animals, as the grampus, gulls, &c., it multiplies with astonishing rapidity. Its great and regular migrations, during summer, along the coasts of Europe, particularly the Orcades, Norway, &c. have given employment to many thousand people, from the 12th century. —*Blumenbach*.

It is, however, asserted, that "we have no satis-

factory authority for believing that herrings breed in the northern seas, when they have never yet been observed in the real icy seas; nor have they even formed a fishery on the coast of Greenland and Iceland. When they first appear on the coast of Scotland, it is not in shoals, but in small numbers; and they are then taken with a feather, or fly, and a rod. There is nothing to indicate a migration from the north; on the contrary, there is every reason to believe they breed in our own seas: but, both the time of their breeding, and their visits, are irregular and capricious. Much good money has been sunk by erecting buildings, and establishing fishing stations, which the herrings afterwards abandoned."—*Notes in Science*, 1828.

Sir Humphry Davy says: "The great supposed migrations of herrings from the poles, to the temperate zone, have appeared to me to be only the approach of successive shoals from deep to shallow water, for the purpose of spawning."—*Salmonia.*

In a recent paper, in *Jameson's Journal*, Major W. M. Morrison supports that view of the migration of gregarious fish, which leads to the supposition, that they do not actually travel from north to south; but that, in accordance with climate, successive shoals approach the coasts for the purpose of spawning; and this view he supports by some interesting facts. The nets of Hastings are always cast north and south, in order that they may drift with the ebbing and flowing of the tide, which takes the direction of east and west in that part of the British Channel; and it is curious, that while those fish which are encumbered with roes, are caught in great numbers on the east side of the nets, they are not met with in a greater proportion than one in about one hundred without roes on the west side.

At Cairo, the Arab cooks are said to prepare the herring for the table, in such a manner, as to intoxicate the eaters.

Why should the barbel be eaten with great care?

Because its roe is poisonous, and has often given rise to dangerous symptoms when eaten.

Why has a species of chætodon the upper jaw ending in a tube?

Because it may, through this tube, throw water on the insects upon aquatic plants, so that they may fall and become its prey.

Why is the jaculator fish of Java, so called?

Because it kills insects and other prey, by ejecting, from its tubular mouth, single drops of water. Thus, when it spies a fly sitting on the plants that grow in shallow water, it swims 4, 5, or 6 feet from them, and then takes aim as above, when it rarely fails to strike the fly into the sea, where it soon becomes its prey.

Why is a certain fish of Ceylon called the leaf-moon?

Because its outline has the appearance of a broad crescent, in the centre of which, the tail, short and fan-shaped, projects like a leaf.

ANGLING.

Why is a river better for fishing, after a flood from rain?

Because it brings the fish up, who know when rain is coming; and likewise brings down food, and makes the fish feed. But when the water is raised by a strong wind, the fish never run, as they are sure to find no increase in the spring-heads, which are their objects in running.—*Sir H. Davy.*

Why do experienced anglers fish with their face towards the sun?

Because, though inconvenienced by the light, they do not then alarm the fish; whereas, if they fished with their backs to the sun, and it was not very high, their own shadows, and those of their rods, would be thrown upon the water, and the fish would be alarmed whenever a fly was thrown.

Thus, Cotton wishes for

A day, with not too bright a beam;
A warm, but not a scorching, sun.

Why do fish not willingly haunt very deep water?

Because, even in summer, it is of very low temperature, approaching to 40°, and it contains little or no vegetable food or insects, which the smaller fishes search for; and the larger fishes follow the smaller. We cannot judge of the senses of animals which breathe water—which separate air from water by their gills; but it seems probable, that as the quality of the water is connected with their life and health, they must be exquisitely sensible to changes in water, and must have similar relations to it, that an animal with the most delicate nasal organs has to air.—*Sir H. Davy.*

Why does a flood, or a rough wind, assist the fly-fisher?

Because it not only obscures the vision of the fish, but, in a river much fished, changes the appearance of their haunts; large trouts almost always occupy particular stations, under, or close to, a large stone or tree; and, probably, most of their recollected sensations are connected with this dwelling.—*Sir H. Davy.*

Why is it evident that the inferior animals have a knowledge of time?

Because those which leave a particular dwelling at stated intervals, measure the distance they ought to travel, and return with regularity to their home. The sun appears to be their great regulator, as they are influenced by the changes which take place with his light and heat. Fishes, and other animals, which live in the sea, or search for food on its shores, appear to regulate themselves by the motions of the tide. The regularity of the crowing of the cock, has been long admired; but it appears difficult to point out the measure of time by which it is governed.*—*Fleming.*

* See ORIGINS and ANTIQUITIES, Part III. p. 38.

WORMS.*

GENERAL ECONOMY.

Why are certain animals called invertebral?

Because they are destitute of skull and vertebral column, for the protection of the brain and the spinal marrow.

Why are these animals furnished with crusts, scales, or hairs?

Because these appendices may supply the place of bones, and serve as a protection to the viscera, and as supports to the muscles. The blood, in those cases where a circulating fluid can be detected, is usually of a white or gray colour, seldom inclining to red.

Why are certain of these animals called mollusca?

Because they are soft, (from *molluscus*, Latin) and have no skeleton. Their muscles are attached to their skin, and their nervous system is irregular in its form and distribution.

Why are others called annulosa?

Because they have the body divided into joints or rings, (from *annulus*, a ring) and, they either possess articulated feet or have certain processes which supply their place.

Why are some mollusca enabled to creep?

Because they alternately contract and relax the foot, or expand their muscles, which serve as suckers, and make their motion analogous to that of serpents.

Why do others swim?

Because they make serpentine undulations of the foot and body, or exert tentacula, or expanded portions of the integuments. Many species rise or sink in the water by aid of an organ somewhat resembling the

* Arranged in Six Orders:—1. Intestina—2. Mollusca—3. Testacea—4. Crustacea—5. Corallia—6. Zoophyta.

air-bladders of fishes. Others keep, or shift their position by a sudden jerk, produced by shifting the valves of the shell rapidly. The common scallop and the river mussel have the latter properties.

Why have some of these animals extraordinary power of suction?

Because they may fix themselves more securely; the sucker acting in the same manner as the moistened circular piece of leather, with a cord fixed to its centre, and applied to the surface of a stone. In the limpet, its surface is smooth and uniform; and the adhesion appears to depend on its close application to every part of the opposing surface. In other animals, as the leech and sea-urchin, the sucker is formed at the extremity of a tube; the muscular motions of which may serve to pump out any air which may remain, after the organ has been applied to the surface of the body. In a third class, the sucker is more complicated in its structure, consisting of many smaller ones, so disposed as to act in concert, as on the breast of the lump-fish. Neither quadrupeds nor birds possess any sucker. It is found among a few reptiles and fishes. The extremities of the toes of many insects possess complicated suckers. Among the mollusca and zoophytes, there are few in which suckers in some form do not exist. By means of this organ, whose power of cohesion must depend, not only on the extent of its surface, but the strength of the muscles which produce the vacuum, these animals can remain in the same spot, although acted on by forces to which their own weight could offer no adequate resistance. Pennant states that he heard of a lamprey, which was taken out of the Esk, weighing three pounds, adhering to a stone of twelve pounds weight suspended at its mouth.—*Fleming.*

Why are zoophytes considered the lowest family of animals?

Because they have not a heart or system of vessels,

THE EARTH-WORM.

Why is the earth-worm so called?

Because it swallows the soil or earth, from which, in its passage through the intestines, it extracts its nourishment.* Mr. Leon Dufour has recently determined the earth-worm to be an oviparous and not a viviparous animal. The eggs resemble a chrysalis or a cocoon, but their pulp, &c. prove them to be true eggs.

The lower we go in the scale of creation, the more surprising is the reproductive faculty. The gardener cuts the earth-worm with his spade; but the injury, far from diminishing animal life, increases it; for each portion of the animal so divided, becomes a separate creature, having a system of parts speedily regenerated.

THE LEECH.

Why does the leech advance faster than other worms?

Because the organs of adhesion are double, one at each extremity, the mouth adhering to one part of the surface, while the tail is brought up towards it, and is fixed, the body being at this time like an arch. The head then quits its hold, the body extends itself, and, when at full length, the head is then attached, and the tail brought up. By these alternate movements, the leech, at every *step*, advances nearly the length of its own body.—*Fleming.*

The stomach occupies the greatest part of the body in the leech, and is divided internally, by means of ten imperfect fleshy partitions, into somewhat separate portions.

* In a recent paper in the *Foreign Quarterly Review* we read of other earth-eaters, in South America, where the women, children, serpents, lizards, and ounces of the river St. Francisco have a singular and most economical propensity of eating earth. It seems that the soil contains a small portion of salt-petre, which is agreeable to the palate. Boys and girls, however, are less select in their tastes, and sometimes eat the whitewash off the walls, and occasionally, wood, charcoal, or cloth.

Why is the wound of the leech of three-sided form?

Because within its mouth are three semicircular projected bodies, with a sharp toothed edge, with which it bites.

Why is a certain species called the flying leech?

Because it has the power of springing, by means of a filament, to a considerable distance. It is much smaller than the common leech; the largest, when at rest, not being more than half an inch long, and may be extended till it becomes a fine string; the smaller ones are very minute. It is common in the jungles in Ceylon; Bishop Heber tells us that "the native troops on their march to Canely, suffered very severely from the bites of flying leeches, occasionally even to the loss of life or limb: their legs were covered with them, and streamed with blood."

SNAILS.

Why do snails carry their shells with so much ease?

Because they are bound to the shells by two muscles, which arise from the pillar, and having penetrated the body below its spiral part, run forward under the stomach, and spread their fibres in several slips, which interlace with those of the muscles proper to the foot, the substance of which they enter. It is obvious from this direction, that on their contraction, the body of the snail must be drawn within the shell. When it wishes to re-issue, the head and foot are forced out by circular fibres, which surround the body immediately above the foot.—*Cuvier.*

Blumenbach says "Whether the black points, at the extremities of what are called the horns of the common snail, are organs which really possess the power of vision, is still problematical."—*Compar. Anat.*

Why does the snail mark its track with a silver line of concrete slime?

Because the slime enables the slug to attach one part of its body more firmly to the surface on which

it is moving, while it drags up the remainder to a new position.

In England the rustic maiden once read her fortune in the meanders of a snail:

> Last May-day fair I searched to find a snail,
> That might my lover's name reveal;

She placed it on "the milk-white embers spread," when

> Slow crawl'd the snail; and, if I right can spell,
> In the soft ashes mark'd a curious L.
> Oh! may this wondrous omen lucky prove,
> For L is found in Lubberkin and love.—*Gay.*

Why are snail-shells so often found adhering to rocks, &c?

Because the snails have then retired to torpidity, previous to which they have formed an operculum or lid from the mouth of the shell, by which they attach themselves, and at the same time close up even all access of the air. The winter lid of some snails resembles a piece of card paper.

All the land *testacea* (shell animals) appear to have the power of becoming torpid at pleasure, and independent of any alterations of temperature. Thus, snails, if placed in a box at midsummer, will attach themselves to its sides, and remain in this dormant state for several years. Even in their natural haunts, they are often found in this state during the summer season, when there is a continued drought. With the first shower, however, they recover, and move about, and at this time the conchologist ought to be on the alert.

Why do snail-shells become more brilliant when plunged into boiling water?

Because the skin or film with which they are covered, is then removed.

Why have some snail-shells elevated ribs, and others slight depressions?

Because the shell is gradually formed by the snail, by aid of a fold or membrane, to be perceived where the body rises into the shell. This part is denominated

the *collar*, from the manner in which it surrounds the body, and it is the organ which secretes the shell. The animal is born with the rudiments of its future covering, and by its gradual increase of growth is enabled to push the collar for a space, and from time to time beyond the original margin. In these operations, a thin layer of membraneous and calcareous matter is excreted and deposited, which is gradually thickened by successive layers being laid on within the first, by the repeated protrusions and retractions of the collar. This portion being formed, the animal commences another, and finishes it in the same manner; and the extent of each portion is marked as above. There is not, as has been implied, a regular and alternate deposition of a layer of membrane, and a layer of lime; but, in all shells, the animal and earthy matters are obviously secreted and deposited at the same moment, and in commixture.

Why is the snail found in greater numbers, and thriving better, in chalky districts than elsewhere?

Because chalk is the snail's best food, and the food is the source of the lime of which it forms its shell. Lime is not, however, necessary to be eaten for the perfect formation of the operculum, (or lid of the shell) as is remarked in the *Zoological Journal* by Mr. Bell; many snails in his possession having formed that part, though during the whole summer they had no access to any preparation of lime.

Why do the land snails vary most in their colours?

Because they are most exposed to the operation of light; while those shells, which, within the bodies of their snails are always white, as are also those which live in holes whence they never issue. Another striking proof of the blanching effect of darkness is furnished by some bivalve shells, as scallops, permanently affixed by their lower valve, which is constantly white, while the upper one may possibly be variegated with bright colours.

Why was a certain species of snail reared with much pains among the Romans?

Because they were eaten as great delicacies among epicures. For this purpose, they were kept in sties, and fattened with bran and sodden wine; and on this generous fare they grew occasionally to such a size, that, according to Varro, the shell would hold full ten quarts! The younger Pliny's supper of three snails, two eggs, a barley cake, a lettuce, sweet wine, and snow, was therefore no very spare meal.

Snails are still eaten in great numbers on the continent of Europe, particularly in Lent. In Switzerland they are fed in many thousands together in gardens; in Italy they are much liked; in Paris they are sold in the market; and, in Vienna, they are charged at an inn the same as a plate of veal or beef, or a dish of frogs at a French restaurateur.* The Greeks are also great eaters of land-snails, but they have not the art of fattening them. The usual mode of preparing them for the table is either boiling, frying them in butter, or stuffing them with force-meat.

Why were edible snails introduced into England about the middle of the sixteenth century?

Because of their being recommended for consumptive complaints by the physicians of that day; indeed, snail-water is still to be found in the pharmacopœia of the last century.

Snails were introduced as above by Charles Howard, one of the earls of Arundel, who brought them from Italy for the cure of his countess. Sir Kenelm Digby likewise patronised the remedy. Elias Ashmole says, the earl scattered them on the hills about Dorking, in Surrey, and between Albury and Horsley, near Guild-

* There is in Brussels a market for frogs, which are brought alive in pails and cans, and prepared for dressing on the spot. The hind limbs, which are the only parts used, are cut from the body with scissors, by the women who bring the animals for sale.

ford. We have noticed, in our *Promenade round Dorking*, their being on Box Hill, where to this day large snails abound. They were also introduced a few years since into a curious garden in Scotland, where they did not prosper.

Why is the Cornwall mutton of superior flavour?

Because of the nourishment afforded to the sheep by feeding on snails. Thus, the sweetest mutton is reckoned to be that of the smallest sheep, where the sands are scarcely covered with very short grass. "From these sands come forth snails of the turbinated or spiral kind, which spread themselves over the plains early in the morning, and whilst they are in quest of their own food among the dews, yield a most fattening nourishment to the sheep."—*Borlase's Hist. Cornwall.*

Why are snails eagerly sought by the blackbird and the thrush?

Because they are substituted for their summer food, which winter may have destroyed. They break the shells of the snails, by reiterated strokes against some stone; and it is not uncommon to find a great quantity of fragments of shells together, as if brought to one particular stone for this very purpose.

THE MAN-OF-WAR.

Why is a certain worm called the man-of-war?

Because it has the skill and knowledge of an experienced navigator, and is in itself *a little ship.* Its evolutions are according to the winds; it raises and lowers its sail, which is a membrane provided with elevating and depressing organs. When filled with air, it is so light, that it swims on the surface of alcohol, and is at the same time provided with a structure which furnishes it with the necessary ballast. In high winds it descends into the deep. From the under side of the body proceed tubes, 20 feet in length, which wind in a spiral form like a screw, serving at once as anchors, defensive and offensive weapons, air-tubes,

and feelers. It has the colours of the rainbow; its crest or sail is intersected with pink and blue veins; its length is from six to eight inches. The fibres contain a poisonous fluid, which stings like nettles. We abridge these curious facts from a Memoir of Dr. Tilesius, who accompanied Krusenstern in his voyage round the world.

CUTTLE-FISH.

Why does the cuttle-fish differ in structure from other mollusca?

Because it has three hearts—two of which are placed at the root of the two branchiæ; they receive the blood from the body, and propel it into the branchiæ. The returning veins open into the middle heart, from which the aorta proceeds.—*Cuvier.*

The cuttle-fish was esteemed a delicacy by the ancients. Captain Cook also speaks highly of a soup he made from it; and the fish is eaten at the present day by the Italians, and by the Greeks, during Lent.

Why does the cuttle-fish, when pursued, eject a black inky liquor?

Because it may darken the water, and thus hide itself from its enemies.

It is a completely mistaken notion, that the black fluid of the cuttle-fish is its bile; for the ink-bag is at a considerable distance from the gall-bladder. According to Cuvier, the Indian Ink, which comes from China, is made of the above fluid.

Why are the jaws of the cuttle-fish fixed in the flesh of the animal?

Because there is no head to which they can be articulated. They are of horny substance, and resemble exactly the bill of a parrot. They are in the centre of the lower part of the body, surrounded by the tentacula. By means of these parts, the shell-fish which are taken for food, are completely triturated.

Why have cuttle-fish small holes on their arms?

Because, by means of them, they fix themselves in the manner of cupping-glasses. These holes increase with the age of the animal; and, in some species, amount to upwards of 1,000. They have the power of reproducing their arms, which are often torn or nipped off by shell and other fishes.

The suckers of the cuttle-fish, are irregularly scattered on the arms and feet. The back is strengthened by a complicated calcareous plate, lodged in a peculiar cavity. This plate has long been known in the shop of the apothecary, under the name *Cuttle-fish bone*, which was formerly prized as an absorbent, but is now chiefly sought after for the purpose of polishing the softer metals.—*Fleming*.

Why is it improper to call this plate "bone"?

Because, in composition, it is exactly similar to *shell*, and consists of various membranes hardened by carbonate of lime, without the smallest mixture of phosphate.—*Hatchett, in Philos. Trans.*

The most remarkable species of cuttle-fish inhabits the British seas; and, although seldom taken, its bone is cast ashore on different parts of the coasts, from the south of England, to the Zetland Isles. We have picked up scores of these bones, or shells, on the Sussex coast, but never found a single fish.

The cuttle-fish, it may be added, is the only animal of its class, in which any thing has hitherto been discovered, at all like an organ of hearing, or has been shown to possess true eyes.

Why are sea-grapes, as they are called, often picked up on the sea-shore?

Because many kinds are the *ovaria*, (or egg-bags) of cuttle-fish, and similar species.

Why are certain sea-worms called animal flowers?

Because they display beautiful membraneous expansions, resembling the petals of flowers: these are, in

fact, the breathing organs, acting at the same time as tentacula.

Why does the stomach of some medusæ resemble the roots of trees?

Because it has branching tentacula, on which canals commence by open orifices; these unite together to form larger tubes; and the successive union of these vessels, forms at last four trunks, which open into the stomach, and convey the food into that cavity. Cuvier has formed a new genus, under an appellation derived from the above comparison—the *rhizostoma;* from the Greek words, a root and a mouth.

TESTACEA—SHELLS.

Why is the study of shells much more important than some would represent?

Because, being found in abundance, in a great variety of rocks and positions, they constitute the *medals of the ancient world;* and, from an accurate acquaintance with their different species, and with the nature of the animals that represented them, many curious and important deductions respecting the formation and changes of the crust of the earth may be drawn.—*Thomson's Hist. Royal Soc.*

Testacea, (or shell animals) are classed in families, according to the number and form of the shells. Thus *multivalve,* or with many valves; *bivalve,* muscles, &c.; *univalve,* with regular windings, snails; and *univalves,* without such windings.

Why have shells served many purposes more useful than that of ornament?

Because of their service in the domestic economy of various nations. Thus, in the south of China and in India, the thin layers of some large flat shells, when polished, are used instead of glass for windows. Many of the domestic utensils of savage people are shells; and it must have been observed, that we frequently

imitate these in our porcelain. In India, drinking-cups are formed of the nautilus; and in other less civilized nations, shells are converted into knives, spoons, fishing-hooks, razors, &c. In Zetland, a certain shell, suspended horizontally by a cord, is used as a lamp, the canal serving to hold the wick, and the cavity to contain the oil. Is it not probable that some of the most elegant patterns left us by the Greeks have been suggested by a similar primitive practice?

In mentioning the benefits of shells, we must not forget the celebrated Tyrian purple, which was procured from a univalve shell fish, and was contained in a transparent and branching vessel, placed behind the neck of the animal. A shell, called *Purpura*, of our own shores, furnishes a liquid of similar qualities, and is supposed to have been resorted to by the ancients.

Why was the term "shell" formerly expressive of the greatest hospitality?

Because, in the days when Ossian sang, the hollow shells of the scallop were the drinking-cups of Fingal and his heroes, and the flat shells their plates. Thus, in Ossian: "Thou, too, hast often accompanied my voice in Branno's hall of shells." "The *joy of the shell* went round, and the aged hero gave the fair."

Why do shells increase in size?

Because they consist of layers of an earthy salt, with interposed membranes of animal matter, resembling coagulated albumen, and they grow, by the addition of layers of new matter, to the edges and internal surface. When broken, the animal can cement the edges, and fill up the crack, or supply the deficiency when a portion is abstracted.—*Fleming.*

As an instance of the great strength of such cement, it was, in 1829, stated in *Brande's Journal*, that the large snails which are found in gardens and woods, discharge a whitish substance, with a slimy and gelatinous appearance, which has been known to cement

two pieces of flint so strongly, as to bear dashing on a pavement without the junction being disturbed, although the flint broke into fragments by fresh fractures.

Why are shells of different colours?

Because the colour is secreted by the animal, along with the matter of the shell.

Why is the inner surface of all shells very smooth, and apparently denser and harder than the outer?

Because the animals, to form this inner layer, excrete the lime in nearly a pure state, that is to say, mixed with much less animal matter; so that, in concreting, the particles become very close and compact, and receive a polish from the repeated frictions of the soft parts.

Why does a dry thin skin cover the external surface of most shells?

Because, being a dried sheet of coagulated albumen effused at the same time, or, perhaps, even prior to the first layer, it may protect the subjacent or more chalky layers from the action of the air or water during their consolidation.—*Mr. Gray, in the Zoological Journ.*

Blainville, and the French naturalists, generally, suppose that the above covering is the true epidermis, or scurf-skin, raised from its position by the deposition of the shell underneath it; but we think this is not tenable.

Why are old shells remarkably strong?

Because a shell having attained its full growth, the changes which the animal further effects are almost limited to some increase of its thickness; not, however, by the addition of any new layers, but by the effusion of vitreous matter. Hence, holes and canals, previously visible, are now filled up; the aperture contracted, and the margins strengthened and enlarged; the upper part of the spire, perhaps, filled and made more solid. The external layers now lose their epidermis; the colours become paler; parasites deform

and perforate the outer surface; death at length overtakes the architect, and the shell decays under the influences of the water and the air. What an epitome is this of the proudest life,—till death

> Comes at the last, and with a little pin
> Bores through his castle-wall, and—farewell king.

THE PIERCE-STONE.

Why is a certain worm called the pierce-stone?

Because it bores passages in rocks, even in the hardest marble, in the stems of coral, oyster-shells, the bottoms of ships, &c. and excavates a habitation at the termination of the passage.—*Blumenbach.*

The *Lithophagus* is another of these stone-boring animals, and an instance of its depredations on the hardest marble is shown by the celebrated, but mysterious, phenomenon, of the three large columns of *Cippolino antico*, in the temple of Serapis, at Pozzuolo, which, though at an elevation of twenty-seven feet above the level of the Mediterranean near them, are perforated in a circular manner by these animals.

THE OYSTER.

Why is the shell of the oyster termed "fixed"?

Because it has one valve cemented to the rock; and though the oyster itself has a heart, blood-vessels, brain, gills, and stomach, it depends on the bounty of the waves for all the objects of its sensation and nourishment. It is, however, an admirable provision of nature, that although the oyster and other natives of the water are thus stationary themselves, the fluctuations of the element in which they live, produce a variety in the scene, and daily bring new objects in contact with their organs of sensation.

Of oysters there are several species. Thus, in a little *Manuel de l' Amateur d'Huitres*, before us, we count upwards of forty-five different kinds which are known to naturalists.

Why does an oyster open its shell at the time of flood?

Because it may participate and enjoy the returning tide. This is done, as well as the shell closed, with prodigious force, by means of a strong muscle at the hinge.

Mr. Carew, in his *Survey of Cornwall*, 1602, tells us of an oyster having opened its shell, and three mice attempting to seize it; but the oyster clasped fast its shell, and killed them all.

THE MUSSEL.

Why is the common mussel enveloped in a thread-like substance termed byssus?

Because these threads are united in the body to a secreting gland, furnished with powerful muscles, and, at the other extremity, glued to the rock or other body to which it connects itself.—*Fleming.*

Why are the pinnæ, or sea-wings prized?

Because of their beard, by means of which they attach themselves, and from which gloves, &c. are manufactured at Smyrna, Tarentum, Palermo, &c.

A pair of gloves made of this material may be seen in the British Museum.

PEARLS.

Why are pearls found in the oyster?

Because they consist of the morbid secretions of the fish, situated either in the body, or lying loose between it and shell; or, lastly, fixed to the latter by a kind of neck. It is said they do not appear until the animal has reached its fourth year. There is nothing peculiar in their chemical composition, being merely carbonate of lime.

The Romans gave almost incredible prices for pearls. Their finest pearls were from the Gulf of Persia, and the Indian Ocean; though it is matter of history that Cæsar was induced to invade Britain from some exaggerated accounts he had heard of the pearls of our coasts, or rather of our rivers; but, if

these were his objects, the mercenary conqueror was disappointed, for they were found to be of bad colour and inferior size, nor have they since improved.

Why did Linnæus owe his patent of nobility to the pearl?

Because he received that elevation for a discovery of causing the fresh-water mussels of Sweden to produce pearls at his pleasure. It is conjectured that he accomplished this by drilling small holes through the shells; but his method is not certainly known.

THE NAUTILUS.

Why is the Paper Nautilus also called the Argonaut?

Because of its origin from *Argonautes*, the companions of Jason, in the celebrated ship Argo, and from the Latin *naus*, a ship; the shells of all the Nautili, having the appearance of a ship with a very high poop. When *sailing*, the animal expands two of its arms on high, and between these supports a membrane which serves as a sail, hanging the two other arms out of its shell, to serve as oars, the office of steerage being generally served by the tail.

When the sea is calm, whole fleets of these Nautili may be seen diverting themselves; but when a storm arises, or they are disturbed, they draw in their legs, take in as much water as makes them specifically heavier, than that in which they float, and then sink to the bottom. When they rise again, they void this water by numerous holes, of which their legs are full.

The cuttle-fish, from its frequently being found in the shell of the Argonauta, was long considered the fabricator of the shell; but, more recent observation has proved it to be merely the piratical occupant.

END OF PART VIII.

KNOWLEDGE FOR THE PEOPLE:

OR THE

PLAIN WHY AND BECAUSE.

PART IX.—ZOOLOGY—INSECTS.

ZOOLOGY.

INSECTS.

GENERAL ECONOMY.

Why are insects so called?

Because they have a separation in the middle of their bodies, whereby they are cut (*insectus*, cut or notched, *Lat.*) into two parts, joined by a small ligature, as in the common house-fly.

Why are the history and descriptions of insects called Entomology?

Because of the origin of that term from the two Greek words, *entoma*, insects; and *logos*, a discourse.

Why is the study of insects a source of perpetual variety?

Because the localities of insects are, to a certain extent, constantly changing. Insects, also, which are plentiful one year, frequently become scarce, or disappear altogether the next—a fact, strikingly illustrated by the uncommon abundance in 1826 and 1827, of the seven-spot lady-bird in the vicinity of London, though during the two preceding summers, this insect was comparatively scarce, while the small two-spot lady-bird was plentiful.—*J. Rennie.*

Why did the ancient philosophers believe that maggots, flies, and other insects, were generated from putrifying substances?

Because they were found about animal bodies in a state of decomposition; and the circumstance was merely noticed without any previous or accurate observation of the means by which they were first produced.

The fact is now established, that all insects come from eggs, as plants do from seeds.

Why is the life of insects the briefest of all existence?

Because the males rarely survive the inclemency of the first winter, and the females die after having deposited their eggs.

Why may the ephemeral nature of many tribes of insects be considered rather apparent than real?

Because the wonderful metamorphoses to which they are subjected, conceal their identity from the eye of the uninitiated, and greatly interfere with a continuous tracing of the same individual, from the egg to the perfect form. For example—many aquatic flies, such as the Ephemeræ and others, whose declared and more obvious existence, does not exceed a few hours, have, previous to their assuming the winged state, spent months or even years in the banks of rivers, and beneath the surface of the stream.

Why is the Linnæan arrangement of insects considered superior to others?

Because the primary divisions of Linnæus are taken from circumstances connected with the condition of the wings. The simplicity of this method, and the obviousness of the characters which have been employed, have secured for this system a decided preference among the entomologists of Britain.—*Fleming.*

Why is the first Linnæan order of insects called Coleoptera?

Because they have wings in sheaths: (*koleos, a* sheath—*pteron,* a wing;) as the common black-beetle: —4,087 species.

Why is the second order called Hemiptera?

Because they have half of one wing overlaid by the other: (*hemisu,* half—*pteron,* a wing;) as the common cockroach:—1,427 species.

Why is the third order called Lepidoptera?

Because they have wings covered with very fine scales: (*lepis*, a scale—*pteron*, a wing;) as the butterfly:—2,570 species.

Why is the fourth order called Neuroptera?

Because they have reticulated or nerved wings: (*neuron*, a nerve—*pteron*, a wing;) as the dragon-fly:—174 species.

Why is the fifth called Hymenoptera?

Because they have membraneous wings: (*hymen*, a film—*pteron*, a wing;) as the bee:—1,265 species.

Why is the sixth order called Diptera?

Because they are two-winged: (*dis*, twice—*pteron*, a wing;) as the common gnat:—692 species.

Why is the seventh order called Aptura?

Because they have no wings: (*a*, privative—*pteron*, a wing;) as the spider and the centipede:—679 species.

About thirty years ago, the recorded number of insects amounted to about eleven thousand; but a great additional number has since been discovered and described: Humboldt says 44,000.

Why is it evident that the nourishment in insects is not merely calculated for the preservation of the individual, but more particularly for the purpose of consuming organized matter?

Because insects must eat,—not solely to satisfy hunger, but also to destroy carrion, to annihilate other insects, to extirpate weeds, &c.; an admirable provision, to the execution of which, besides the almost incalculable number of species, the extremely rapid multiplication of many, the unexampled voracity of others, and the quickness with which digestion is carried on in their very short intestinal canal, all tend to contribute. Thus, it is known, that a caterpillar will, in twenty-four hours, consume more than three times its own weight.—*Blumenbach.*

Why may the abode of insects on and under the surface of the earth, be considered as much less limited than that of the other classes of animals?

Because they are found on almost all warm-blooded animals; and even the larger insects, as bees, chaffers, &c. are infested by peculiar kinds of lice. There are but few plants, also, (such as, perhaps, the yew, savine, and most tree-mosses,) which do not serve for the abode and support of known insects. Many again, as the oak, are frequented and inhabited by more than a hundred distinct species. Generally, however, as insects are diffused over the earth, the residence of individual species is not less frequently limited to a very small number of animals and plants, or even particular parts of them.

Why are insects so serviceable in the general economy of nature?

Because some destroy numerous kinds of weeds in the bud, or extirpate them when full grown. Others feed on carrion, live in dung, &c., and thus destroy, disperse, and change noxious animal substances; on the one hand, obviating the infection of the air; and on the other, promoting the fertilization of the earth. It is in this way, for instance, that flies are so serviceable in warm climates. So again, innumerable insects effect the impregnation of plants in a very remarkable manner.

Why are insects important in the arts?

Because of the ready adaptation of their labours to many of the conveniences of life. Thus, mead is prepared in many parts of Europe from the honey of bees; silk is employed for clothing: several insects, as cochineal, afford excellent dyes. Galls are employed for ink; wax, for lights, and other purposes. Lac, employed to make varnish, sealing-wax, &c. is produced by a certain Indian species of coccus. As medicines, we have Spanish flies, ants; and, adds Blu-

menbach, the oil-beetle, recommended for hydrophobia, and many beetles for relieving tooth-ache.

Why are the eyes of certain insects termed compound?

Because they consist of an aggregation of smaller eyes, or those which are termed *simple*; for their general convexity is divided into one immense number of small hexagonal or six-sided convex surfaces, which may be considered cornea. Simple eyes are formed in the larvæ of many winged insects, which upon their last or complete metamorphosis, at the same time that they receive their wings, gain the large compound eyes. The late Mr. T. Carpenter, the optician, of Regent-street, paid more attention to this branch of entomology than any man of his time. By aid of a powerful microscope, he experimented upon upwards of 200 insects; the most familiar of which were the boat-fly, dragon-fly, ant, gnat, bee, wasp, ichneumon, cockchaffer, peach-fly, earwig, grasshopper, locust, cricket, and cockroach. His results were a conviction that the whole of these insects did really possess numerous and distinct eyes, varying in number according to the species of insect; in some, upwards of 40—in others, 1,000; and upwards of 30,000 in some species! The eyes of the libellula, or dragon-fly, Mr. Carpenter says, are, on account of their size, peculiarly well adapted for examination under the microscope. They are a couple of protuberances immovably fixed in the head, and divided into a number of hexagonal cells, each of which contains a complete eye. The external parts of these eyes are so perfectly smooth, and so well polished, that when viewed as opaque objects, they will, like so many mirrors, reflect the images of all surrounding objects: each of these protuberances, in its natural state, is a body cut into a number of facets, like an artificial multiplying glass—but with this superiority in the workmanship, that as in that glass every facet is plain, here every one is convex; they are also much more numerous, and contained in a much

smaller space. Each of the eyes is an hexagon, varying in size, according to its situation in the head; and each of them is a distinct convex lens, and has a similar effect of forming the image of an object placed before it.

Blumenbach observes, compound eyes seem calculated for seeing at a distance; simple eyes, for looking at near objects; at least it may be supposed so, as we find that butterflies, in their perfect winged state, have such large compound, telescopic eyes; whilst, as caterpillars, they have small simple ones. Only a few insects can move their eyes, and from this fact has been deduced a probable explanation of at least one object of the numerous facets or surfaces of which the compound eyes of insects are composed.

Leuwenhoeck has counted 17,235 facets in the cornea of a butterfly.

Why have insects antennæ or feelers?

Because the organ of touch is not generally distributed over the body, and the antennæ are considered as appropriated to this sense. These organs are two or more in number, and are present in all the crustacea and insects, but wanting in the arachnidæ, or spider genus. They are situated on the head, usually between the eyes and the mouth. They consist of a number of joints, in general capable, by their flexibility of examining the surface of a body.—*Fleming.*

Why are these antennæ particularly necessary to insects?

Because of the insensibility of their outward coat, which is generally of a horny consistence; and also from their eyes being destitute, in most instances, of the power of motion.

The feelers of insects are better adapted for exploring the condition of the surfaces of bodies than any organ which *we* possess. But their sensibility of touch is limited to particular qualities, or confined within

narrow bounds. The human hand, on the contrary, by its motions, the pliability and strength of the fingers, and the softness of the surface, is the most extensive and perfect organ of touch possessed by any animal.—*Fleming.*

Why have insects cushions on the under surface of their joints?

Because these cushions being either soft and smooth on the surface, or enlargements closely covered with short hairs, by their elasticity and resistance, aid the animal in climbing and leaping. They have likewise suckers, which, in all, are capable of being applied to the surface of a smooth body. By these means those insects which walk upon walls and trees, are enabled to overcome the resistance of gravitation.

Why does the mouth of crustacea and some insects differ from that of red-blooded animals?

Because it is formed of two or more jaws placed laterally; these move from without inwards, and, *vice versâ*, whereas those of red-blooded animals move from above downwards, and back again. The parts which are termed the lips of insects, are two bodies; one of which is placed above or in front of the jaws, and the other below or behind them. The palpi (or short antennæ) are articulated to the jaws.—*Notes to Blumenbach's Comp. Anat.*

Why have all insects with jaws the power of masticating hard animal and vegetable substances?

Because these parts are of a firm, horny texture, and in many cases are very large, when compared with the size of the animal. The locust, the dragon-fly, the beetle, especially the stag-beetle, are examples in which the edges are very large and manifest, and often possess tooth-like edges.

Why does the sting of insects not only pierce the skin, but leave considerable pain?

Because the sting is hollow, and conveys the irritat-

ing or poisonous fluid within the wound, from a peculiar bag.

Why does the sting usually remain in the wound which it inflicts?

Because it is barbed at the sides of its point.

Why have insects without jaws long tubular tongues?

Because *they* derive their nourishment chiefly from liquids, which they get from animal or vegetable substances by means of this spiral or tubular tongue, or a soft proboscis with a broad opening, admitting of extension and retraction; or a horny pointed tube, containing sharp bristly bodies internally.

In many species of the butterfly, this proboscis, when not in use, is coiled up like a watch-spring.

Why are insects supposed to possess the organs of hearing, although no traces of such organs have been detected in them?

Because they emit a variety of sounds by the friction produced by their mandibles, their wings, and their legs, which are communicated to others, and understood by them. The proofs of the existence of taste and smell in the different tribes, rest on the same foundation, the evidence of the function being performed. These senses are chiefly used in the animal economy in subserviency to the digestive system. The organs in which they reside are probably the palpi (resembling short antennæ) or the other more flexible parts of the mouth. But these parts are so different in their form from the organs employed for the same purpose in the higher classes of animals, and so diminutive in size, that neither analogy nor dissection can be called in to illustrate the subject.—*Fleming.*

Numerous facts have long ago proved that several insects can distinguish the odorous properties of bodies even at considerable distances. But the organ in which that sense resides has not been clearly pointed out.—*From the German.*

Why is the alleged cruelty of entomological pursuits but a futile objection to the practical studies of natural history?

Because cruelty is an unnecessary infliction of suffering, when a person is fond of torturing or destroying God's creatures from mere wantonness, with no useful end in view; or when, if their death be useful and lawful, he has recourse to circuitous modes of killing them, where direct ones would answer equally well. In utility, the sportsman, from his primary object being amusement, must yield to the entomologist, who adds to the general stock of mental food,—often supplies hints for useful improvement in the arts and sciences, and the objects of whose pursuits, unlike that of the sportsman, are preserved, and may be applied to use for many years. Again: in proportion as we descend in the scale of being, the sensibility of objects that constitute it diminishes. The earth-worm, so far from being injured by cutting, thereby acquires an extension of existence.* Insensibility almost equally great may be found in the insect world. This might, indeed, be inferred *a priori*, since, Providence seems to have been more prodigal of *insect life* than of that of any other order of creatures, animalculæ perhaps alone excepted. We abridge the spirit of this ingenious defence from the valuable *Introduction to Entomology*, by Kirby and Spence, who illustrate the position by observing, "It is not easy, in some parts of the year, to set foot on the ground without crushing these minute animals.* * * Can it be believed that the beneficent Creator, whose tender mercies are over all his works, would expose these helpless beings to such innumerable enemies and injuries, were they endued with the same sense of pain and irritability of nerve with the higher orders of animals?" Instead, there-

* See Earthworm, page 203.

seek to free themselves from what they must no doubt regard as an inconvenient situation.*

Considerations such as those glanced at in the preceding page can never, of course, be so misconstrued as to afford any palliation to wanton or inconsiderate cruelty to the brute creation.

Why does the skin of insects differ from that of the vertebral animals?

Because, in insects, the skin serves the double purpose of protection and support, and represents the cutaneous and osseous system of the latter. Its structure appears much more simple than in the higher classes, as it can neither be said to possess a mucous or cellular web or true skin. It bears the nearest resemblance to the cuticle of the skin of the higher classes, or, rather, all the laminæ of perfect skins are here incorporated into one uniform plate. In some genera it is soft and pliable; while, in others, as some of the weevils, it approaches the consistence of bones, or appears as a calcareous crust in the crabs. In some species it is elastic, in others brittle.—(*Fleming.*) Again, the coat, composed of several portions, moving on one another like the pieces of a gauntlet, also serves to protect the insect from the effects of various accidents.

Why are not the spines and hairs of insects easily rubbed off?

Because they are merely elongations of the skin. It is otherwise with scales. Some of these are inserted into the skin at one end and left free at the other, and in some insects are so feebly connected, as to fall off by touching them with the finger. These scales, in the butterfly, bear a remote resemblance to feathers in their form.

Why do many insects leap, with ease, forwards, backwards, and laterally?

* See Encyclop. Brit., art. Animal Kingdom, vol. iii. 7th edit. 1831.

Because the thighs of their hind legs are of uncommon size, to give room to the requisite number of muscles.

Why do insects fly?

Because the muscles which move their wings take their rise in the breast, and are capable of executing their functions with great celerity.

The flying insects do not possess rapidity of flight proportional to the number and size of their wings. In the coleoptera, the body hangs down during flight, while in other classes it preserves nearly a horizontal position.

The wings are composed of two membranes, an upper one, in which nervures or cords are traced; a lower one, separable from the upper. These nervures or cords contain a spiral vessel, "whence they appear," says Kirby, "to be air vessels communicating with the trachea in the trunk. The expansion of the wing at the will of the insect is a problem that can only be solved, by supposing that a subtle fluid is introduced into these vessels, which seems perfectly analogous to those in the wings of birds; and that thus an impulse is communicated to every part of the organ, sufficient to keep it in proper tension: we see by this, that a wing is supported in its flight like a sail by its cordage."

Why are the wings of insects important to the naturalist?

Because they, in a great measure, furnish the characters employed in classification. Thus, the presence or absence of wings—their number and appendices—their texture and consistence, together with their size, position, and manner of folding up, yield marks which are easy of detection, and which experience has found to be perfect.—*Fleming.*

Why are the upper wings of insects called elytra or wing-cases?

Because they serve as a covering to the inferior

ones. Strictly speaking, these elytra are not wings, since they perform no other motion than elevation and depression, and serve merely to protect the wings when at rest, not to assist them when flying.

Why are not aquatic insects wet with the water in which they reside?

Because the skin is probably smeared with some unctuous matter; comparative anatomy hitherto having failed in detecting any glands subservient to the functions of the skin. In some instances, indeed, the skin resists being wet, even after the death of the animal has taken place for some time, but previous to becoming dry.—*Fleming.*

Dr. Arnott physically attributes it to the weight of the insects not being sufficient to overcome the cohesion of the particles of water among themselves.

In the tribes which swim, the legs are either flattened like the blade of an oar, or produced and ciliated (fringed) on the edges. Some swim upon their back, others upon their belly. Some keep always floating upon the surface, others dive and perform their movements at various depths, regulated by the condition of the organs of respiration.—*Fleming.*

Why were insects and worms formerly called bloodless animals?

Because they are distinguished from the preceding classes by the absence of red blood, in place of which they have a white fluid. In recent times, on account of the absence of vertebræ and ribs, they have received the name of Invertebral Animals.

Among the crustaceous animals, as the lobster and shrimp, the blood is white; while, among some insects, as the grasshopper, and white caterpillar, it is green.—*Hewson, Phil. Trans.*

Why are insects supposed to possess a heart?

Because, both in their perfect and larvæ state, they have a membranous tube running along the back, in

which alternate dilatations and contractions may be observed; but it is closed at both ends, and no vessels can be perceived to originate from it.

Why are not insects concluded to take in air through the mouth?

Because they are furnished with air-vessels or trachea, which ramify over most of their body. These tracheæ are much larger and more numerous in the larva state of such insects as undergo a metamorphosis (in which state also the process of nutrition is carried on to the greatest extent) than after the last, or, as it is called, the perfect change, has taken place.

Why is the mode of respiration observable but in few insects?

Because they in general breathe not by the mouth, but by many *spiracula*, or pores. The greater number of them can live in a vacuum much longer than red-blooded animals, and many in mephitic atmospheres, so fatal to others, and in which animal and vegetable substances become putrid.

Why is the metamorphosis of insects so called?

Because there is not any winged insect which escapes from the egg as such, but all, as well as many insects which have not wings, must first undergo a kind of *change*, at a certain period of their existence. Such insects are called *larvæ*, whilst in the state in which they escape from the egg. They are mostly very small on their first appearance, so that a full-grown caterpillar of the willow moth, for instance, is 72,000 times heavier than when it first issues from the egg. On the other hand, they grow with great rapidity, so that as an example, the maggot of the meat-fly, at the end of twenty-four hours, is 155 times heavier than at its birth. Larvæ are incapable of propagating; they merely feed, increase, and change their covering several times.

The larvæ become nymphæ. Many can move about

and take food in this state. Others, on the contrary, are covered up, as pupæ, (chrysalides, aureliæ) and pass this portion of their life in a state of torpor, without eating or moving. A great change is, however, going on, by which the animal quits its larva state, and leaves its prison a perfect insect.

In popular language, a caterpillar or grub is furnished with feet, and a maggot or gentle is without feet.

Why is the metamorphosis of insects so remarkable a branch of their economy?

Because, by this, not only their external form, but also at the same time their internal structure, contrary to common opinion, is altered in a certain degree. Blumenbach remarks, if the moth existed already formed in the caterpillar, we should at least expect that similar moths should be produced by similar caterpillars. But many American caterpillars, which resemble European ones in the closest manner possible, give origin to moths having totally different forms; and, on the other hand, many remarkably similar moths of both these parts of the world are developed from caterpillars altogether unlike.

Why do certain larvæ form an exterior covering or cocoon?

Because the pupa may be lodged with greater safety. This covering is in some composed of threads of silk. Sometimes only one or two threads are required to keep the pupa in a proper position; in others, the silk is woven into cloth, or so matted together, as to resemble paper. The matter, of which these cases or cocoons are fabricated, is prepared by two long tubes, which take their rise in the abdomen, enlarge as they approach the head, and terminate by a duct, which opens under the labium, or lower lip. By pressing the orifice of this duct to one place, and then to another, the larva draws out the tenaceous threads.—*Fleming.*

Why is the pupa so called?

Because the larva, when so enclosed, resembles an infant in swaddling bands. From the pupæ of many of the butterflies appearing gilt as if with gold, the Greeks called them *Chrysalides*, and the Romans *Aureliæ*, and hence naturalists frequently call a pupa *chrysalis*, even when it is not gilt.

Why do certain insects neither eat nor move when in the pupa state?

Because they derive their nourishment from their stores of fat.

Why are the larvæ more voracious than the perfect insects?

Because their digestive organs are of much greater dimensions than when arrived at maturity; and in the condition of larvæ, insects possess a variety of members, as legs, suckers, hairs, and even stigmata, (respiratory organs) which they do not possess in their maturity.—*Fleming.*

Why have most of the rings of the abdomen an open pore placed laterally?

Because they may serve as breathing holes, through which the fluids of the animal become aërated.

The three portions of the body of insects, the trunk, head, and abdomen, in the different tribes, exhibit very remarkable combinations. In some of the crustaceous animals, these portions are incorporated in the dorsal (or back) surface of the body. In some of the arachnidæ, (or spider genus) the head and trunk are niched, while, in others, the head appears to be distinct, while the trunk and abdomen are incorporated. These modifications are extensively employed in the methodical distribution of the groups.

Why do insects attach their eggs to certain substances?

Because the young, being hatched, are destined to feed on those substances. Thus, the butterfly attaches her eggs to a leaf; the flesh-fly deposits her's upon

carrion; while others insert them into the young of other insects.—*Fleming.*

Why are the eggs of insects, when deposited in the open air, covered by the mother with a kind of varnish?

Because they may thus be protected from the destructive influence of rain, and other accidents.

Among other peculiarities of the propagation of insects, many, as the cochineal worm, the laced-flea, &c. become of an enormous size during pregnancy: thus, in the white ant, it has been calculated that the abdomen of the female, when about to lay her eggs, is 2000 times larger than previous to impregnation.

Why are insects generally considered unsocial?

Because only a few of them afford mutual assistance in their labours. The greater number follow their pursuits singly; many, as spiders, live in society when young, but afterwards separate, and live in a state of solitude, seeing creatures of the same species only at the time of pairing. Swift very aptly observes, "suspense is the life of the spider."

The labours of such insects as live in communities are, however, very remarkable; since they thus build common residences, by their united powers, and under the guidance of an extremely regular, geometrical, innate instinct. There are but few creatures of this class which do not, at least once in their life, give proofs of this natural power of construction; either as the cloth moth and water moth, form a habitation in their incomplete and larva state; or, like others, spin and prepare a receptacle to contain them during their metamorphosis and death-like sleep; or, like the lion-ant, dig pits: or, like the spider, weave webs for their prey, and bags or nets for the security of their posterity, and in which they deposit their eggs.

All those insects which live in society, when exposed to cold, are observed to cluster together, as if to keep each other warm. Some, indeed, when exposed

to cold, become torpid, and revive upon the restoration of a suitable temperature; but there are others, as the honey bee, which resist any reduction of their temperature below their ordinary digestive heat, and preserve it in their dwellings, even during the winter season. John Hunter found a hive in July 18, at 82°, when the temperature of the air was only 54°; and in December 30, at 73°, when the air was only 35°.—(*Phil. Trans.*) When cooled, until they become benumbed, they seldom recover, while the wasp, belonging to the same natural order, can be rendered torpid, and again revived with safety.

Why are entomological studies interesting and advantageous in a moral point of view?

Because the analogies derived from the transformation of insects admit of some beautiful applications, which have not been neglected by pious entomologists. The three states of the caterpillar, larva, and butterfly, have, since the time of the Greek poets, been applied to typify the human being; its terrestrial form, apparent death, and ultimate celestial destination: and it seems more extraordinary, that a sordid and crawling worm, should become a beautiful and active fly; that an inhabitant of the dark and fetid dunghill, should in an instant entirely change its form, rise into the blue air, and enjoy the sunbeams,—than that a being, whose pursuits here have been after an undying name, and whose purest happiness has been derived from the acquisition of intellectual power and finite knowledge, should rise hereafter into a state of being, where immortality is no longer a name, and ascend to the source of Unbounded Power and Infinite Wisdom.—*Sir H. Davy—Salmonia.*

COLEOPTERA.

BEETLES.

Why are insects of this tribe so often eaten by fishes?

Because all such as are abundant in summer are

frequently blown into the water, where they become easy prey. Thus, the brown beetle, or cockchaffer, the fern-fly, and the grey beetle, are devoured in great numbers. But there is hardly an insect that flies, including the wasp, the hornet, the bee, and the butterfly, that does not become at some time the prey of fishes. So voracious are the grubs of some beetles, that the younger ones, when so gorged with those they have devoured, as scarcely to be able to move without bursting, are said, by Kirby and Spence, "often to take advantage of the helpless inactivity into which the gluttony of their maturer comrades has thrown them, and from mere wantonness, it should seem, when in no need of other food, pierce and devour them."

Some beetles are, however, very abstemious. Thus, the rose-chaffer has been kept alive more than eight years, by being fed on crusts of bread soaked in water.

Why was the beetle so often introduced in the buildings of the ancient Egyptians?

Because it was, to all appearance, a highly sacred animal. In the Egyptian tombs, it is found in great variety: of basalt, verde antico, or other stones, and of baked clay. Some have hieroglyphics on them, which no doubt contain some particular prayers, or the commemoration of striking events in the life of the deceased. It is supposed, that the Egyptians hung the beetle to their necks when they went to war; but of this we have no clear proofs. Belzoni mentions a circumstance which, he thinks, will solve the doubt. The beetles are of such a peculiar form, that if they were among the ornaments of the warriors, they would be easily distinguished. He observed a solitary instance of this kind. There is a sitting figure in the tomb of Samethis, which he discovered in the valley below Bebau el Malook, that, by its splendid dress and ornaments, may be intended to represent a king. It has a square plate of basalt hung to its neck, with an

obelisk in the centre, and a figure on each side of it. He believes the above plate to be the only one that was ever found of the king. It has the form of an Egyptian temple, and in the centre is an elevated beetle on a boat, guarded by two figures, one at each side; and, on the reverse of the beetle, is an inscription over a boat, on which are two other figures, exactly like the former. The plate has the holes by which it was hung to a chain or string. Belzoni found also other beetles, with human heads, which he had never seen before.

Why is the dung-beetle also called the dorr?

Because, in old times, *dorr* was a stupid, blundering fellow; and, *to dorr*, was to ding or trouble with noise; both meanings applicable to the heedless flight, and loud noise, made in all the transits of this dung beetle. Such is the conjecture of Mr. Knapp, in his *Journal of a Naturalist*, who also speaks of dung beetles, as clocks—"as the boys call them, a corruption, he thinks, from *cloax*, a vault, a creature from below, which might signify its subterranean residence." Or, burrowing in the filth and ordure, as it does, the epithet *clocca*, the offspring of a common shore, or jakes, would not have been insignificant of its origin and habits."

Why is the dorr beetle thought to counterfeit death to preserve its life?

Because when flying with an apparent fearlessness of harm, if touched, or interrupted, though in no way injured, it will immediately fall to the ground, generally prostrate on its back,—its limbs extended, stiff, and seemingly devoid of life, and suffering itself to be handled without manifesting any signs of animation. In time, finding no harm ensues, its resumes its former state.

The small gray beetle, so well-known for making pin-holes in old furniture, is, however, one of the most

common instances of this habit; and when it does so, it equals, if it does not exceed, the heroic firmness of the American savages, in bearing torture. You may maim these death-counterfeiting insects, pull them limb from limb, and even roast them over a slow fire, without making them move a joint, or exhibit the slightest symptom of suffering pain.

Why is an abundance of the larvæ of the cockchaffer to be feared?

Because, while in this state, lasting four years, they feed on the roots of corn, &c. and have occasionally produced great scarcity. An instance of its ravages, as well as a specimen of notable folly on the part of the sufferers by its rapacity, occurred in 1479, when this insect was cited by a regular Monitorium before the Spiritual Court of Lausanne, who assigned it an advocate from Friburg; but, after an attentive hearing of both parties, and mature deliberation, concluded by placing it under a *ban.*

Why have insects of the sylph family been reputed to dig under dead mice and moles, and bury them, in order to feast on them more securely?

Because they feed on maggots and their pupæ; and in penetrating the ground in search of the last of these, they loosen the soil so much, that the dead animal sinks under the surface, by its own weight, or, if light, is elevated on a hillock.—*Fleming.*

Why is the tortoise-beetle so called?

Because it is of the form of a tortoise, the wing cases projecting all around as a covering for the legs.

Why is the diamond-beetle so called?

Because it is one of the most splendid insects: the gold and colours in the numerous pits marked in rows upon the wing coverings, giving it an inexpressibly fine appearance in a clear light, and particularly under a magnifying glass.

Why is the great water-beetle probably the most ferocious creature of the pool?

Because it has great muscular power, a thick and horny case over its body, eyes large enough to see all the creatures about it, and powerful mandibles to seize and reduce them to fragments. It riots the polyphemus of the pool; and having thinned its herd in one place, is supplied with wings to effect a removal to a fold better furnished. In the larva state, it is almost equally destructive: it swims admirably—its hinder legs are long and brawny—beside being aided by a fringe of hairs, so that they are powerful oars to propel the body with celerity and ease.—*Knapp.*

Why is the oil-beetle so called?

Because of the oily-looking fluid which oozes from it when seized or alarmed. Another beetle is popularly called bloody-nosed, from its ejecting a red fluid from its mouth when caught: it is a very slow walker, but has an admirable contrivance for taking hold of trailing plants, on which it feeds. This consists of cushions of slightly concave thick soft hair, which both adheres by its points, and also produces somewhat of a vacuum, which enables it to walk as easily with its head perpendicularly downwards as upwards.

Why is the stag-beetle so called?

Because the male has forceps on the head resembling the antlers of the stag.

Why has the rhinoceros-beetle grub been selected as a specimen of moulting?

Because it is not the external skin only that these grubs cast, like serpents; but the throat, and part of the stomach, and even the inward surface of the great gut change their skin at the same time. Yet this is not the whole of these wonders; for, at the same time, some hundreds of breathing pipes, within the body of the grub, cast also each its delicate and tender skin. —*Swammerdam.*

DERMESTES.

Why is a species of Dermestes so formidable to the pine forests of Germany?

Because it lodges in such numbers in the alburnum of the pine, that 80,000 of its larvæ have been counted in a tree of moderate size. This affection causes the tree to perish from the summit downwards, its leaves turn red, it loses its resin, and is rendered nearly unfit even for making charcoal, much less timber or fire-wood. This, or a similar insect, has destroyed some of the finest trees in St. James's and the Green Parks, London, although the cause was, for some time, totally unsuspected.—*Blumenbach.*

THE DEATH-WATCH.

Why is a certain insect called the Death-Watch?

Because of its clicking noise, chiefly in the latter end of spring, which may be considered analogous to the call of birds. This is caused by beating on hard substances with the shield or fore-part of its head. The general number of successive distinct strokes is from seven to nine, or eleven. These are given in pretty quick succession, and are repeated at uncertain intervals. In old houses, where the insects are numerous, they may be heard, if the weather be warm, almost every hour in the day. In beating, the insect raises itself upon its hinder legs, and, with the body somewhat inclined, beats its head, with great force and agility, against the place on which it stands. This insect, which is the real death-watch of the vulgar, must not be confounded with a minuter insect, not much unlike a louse, which makes a ticking noise like a watch; but, instead of beating at intervals, it continues its noise for a considerable length of time without intermission. This latter insect belongs to a very different tribe. It is usually found in old wood, decayed furniture, museums, and neglected books.* Phi-

* Mr. Carpenter; mentioned at p. 223.

losophers and wits have written on the habits of this insect. That grave and good man, Sir Thomas Browne, who wrote a book on *Vulgar Errors*, remarks, with great seriousness, that the man "who could eradicate this error from the minds of the people, might prevent the fearful passions of the heart, and many cold sweats taking place in grandmothers and nurses." Baxter, in his *World of Spirits*, observes: "There are many things that ignorance causeth multitudes to take for prodigies. I have had many discreet friends that have been affrighted with the noise called a Death-Watch; whereas, I have since, near three years ago, oft found, by trial, that it is a noise made upon paper by a little, nimble, running worm, just like a louse, but whiter and quicker; and it is, most usually, behind a paper pasted to a wall, especially to wainscot; and it is rarely if ever met with but in the heat of summer."—In the *British Apollo*, 1710, is the following query: "Why Death-Watches, Crickets, and Weasels do come more common against death than any other time? *A.* We look upon all such things as idle superstitions; for, were any thing in them, bakers, brewers, inhabitants of old houses, &c. were in a melancholy condition." Duncan Campbell, in his *Secret Memoirs*, 1732, says, "How many people have I seen in the most terrible palpitations, for months together, expecting every hour the approach of some calamity, only by a little worm, which breeds in old wainscot, &c. endeavouring to eat its way out, makes a noise like the movement of a watch." Grose also tells us that "the clicking of a death-watch is an omen of the death of some one in the house wherein it is heard." Swift, on the other hand, has let fly the shafts of satire, as well as furnished a charm to avert the omen, as follows:—

"A wood-worm,
That lies in old wood, like a hare in her form,
With teeth, or with claws, it will bite or will scratch;
And chambermaids christen this worm a Death-Watch,

Because, like a watch, it always cries click;
Then wo be to those in the house who are sick:
For, sure as a gun, they will give up the ghost,
If the maggot cries click, when it scratches the post.
But a kettle of scalding hot water injected,
Infallibly cures the timber affected;
The omen is broken, the danger is over,
The maggot will die, and the sick will recover."

What an amusing treatise could Swift have written on the dry-rot: his charm, in this instance, is even more effectual than the cauldron in *Macbeth*.

Gay, too, in a pastoral dirge, says:—

"The wether's bell,
Before the drooping flock, toll'd forth her knell;
The solemn death-watch click'd the hour she died."

WATER-FLEA.

Why is the water-flea so called?

Because his abode is in quiet, still water; though, in mild weather, we see him gamboling upon the surface of the sheltered pool, in his shining black jacket. Retiring in the autumn, and reposing all the winter in the mud at the bottom of the pond, he awakens in the spring, rises to the surface, and commences his summer sports. They associate in small parties of ten or a dozen, near the bank, where some little projection forms a bay, or renders the water particularly tranquil; and here they will encircle round each other without contention, each in his sphere, and with no apparent object, from morning until night, with great sprightliness and animation; and so lightly do they move on the fluid, as to form only some faint and transient circles on its surface.—*Knapp.*

LADY-BIRD.

Why is the lady-bird so beneficial to the gardener and husbandman?

Because all the species, both in the larva and the perfect state, feed exclusively on aphides, and never touch vegetable substances. The eggs are usually

placed in a group of twenty or more upon a leaf, where aphides abound; and when the young are hatched, they find themselves in the midst of their prey.—*J. Rennie.*

This, as well as some species of Meloë, has been recommended as a remedy for the tooth-ache.—*Blumenbach.*

THE WEEVIL.

Why is the larvæ of the weevil prized in India?

Because it feeds on the pith of sago, and is eaten itself as a delicacy.

Why are weevils so destructive to wheat in granaries?

Because of their fecundity, and the extraordinary manner in which they are produced. Thus, the female perforates a grain of wheat or barley with the jaws placed at the end of her long proboscis, and deposits a single egg within it; and when the young grub is excluded from the egg, it thus finds provided a fit dwelling and a store of proper food. The parent insect thus deposits its eggs in five or six grains every day, for several successive days. In about seven days' time, the larva is excluded from the egg, and, after feeding its accustomed time, changes into the chrysalis within the grain, and, in about a fortnight afterwards, comes forth a perfect weevil. The parent insect, after depositing its eggs in situations where there would be a supply for the sustenance of its offspring, does not die, but, according to Leuwenhoek, they live throughout the summer and winter; and they feed voraciously on the interior of the grain, both in the larva and perfect insect state. Kirby states, that a single pair of these insects may, in one year, produce above 6,000 descendants.

Why is it recommended to establish a colony of ants near a granary attacked as above?

Because the ants being continually engaged in

searching for food, would soon find their way into the interior of the granary, and feed upon the larvæ of the weevils.

THE GLOW-WORM.

Why do the females of the glow-worm occasionally conceal or eclipse their light?

Because they may secure themselves from becoming the prey of the nightingale or other nocturnal birds. Mr. White, indeed, thought that they regularly extinguished their torch between the hours of eleven and twelve. The light of the glow-worm may perhaps, occasionally deter its insect enemies from making an attack on it, as the wolf and other ravenous beasts of prey are deterred from making an approach on travellers by night, when encircled by fire.—*John Murray.*

Why has not the male glow-worm upward or side vision?

Because the head is margined with a horny band, or plate, under which the eyes are situate. This prevents all upward vision; and blinds, or winkers, are so fixed at the sides of his eyes, as greatly to impede the view of all lateral objects. The chief end of this creature in his nightly peregrinations, is to seek his mate, always beneath him on the earth; and hence his apparatus appears designed to facilitate his search, confining his view entirely to what is before him or beneath him. The first serves to direct his flight, the others present the object of his pursuit: and, as we commonly, and with advantage, place our hand over the brow, to obstruct the rays of light falling from above, which enables us to see clearer an object on the ground, so must the projecting hood of this creature converge the visual rays to a point beneath. *Knapp.*

Why does the female glow-worm shine more vividly than the male?

Because, this distinction being especially noticeable

at the season of love, it is probable that the light serves the purpose of directing the male to her. Some time after the female has laid her eggs, which also shine in the dark, this light disappears in both sexes.—*Blumenbach.*

This theory of the light of the glow-worm has, it is feared, more poetical prettiness than truth. Mr. Rennie, (whose observant genius has raised him to the Professorship of Natural History, in King's College, London,) has lately communicated such facts to the *Journal of the Royal Institution*, as must convince the reader of the fallacy of the above. Unfortunately, the grubs,—which being in a state of infancy, are therefore incapable of propagating—exhibit a no less brilliant light than the perfect insect. De Geer says the light of the grub was paler. He also remarked the same light in the nymph state, which he describes as "very lively and brilliant;" and in this stage of existence it is still less capable of propagating than in that of larva. "Of what use then," he asks, "is the light displayed by the glow-worm? It must serve some purpose yet unknown. The authors who have spoken of the male glow-worms say positively that they shine in the dark as well as the females."

We must devote a page or two to the economy of this very interesting creature, which every body knows by name, but comparatively few have seen. A correspondent of the *Philosophical Magazine* describes it as follows: "The female deposits her eggs in the month of June or July, among moss, grass, &c. These eggs are of a yellow colour, and emit light. After remaining about five or six weeks, the larvæ break their shells and make their appearance; at first they appear white, and are very small, but they soon increase in size, and their colour changes to a dark brown, or nearly black. The body of the larva is formed of eleven rings. It has six feet, and two rows of reddish spots down the back. It emits light in the dark; this

light arises from the last ring of its body under the tail, and appears like two brilliant spots when attentively examined. The larvæ are seen creeping about and shining during the fine nights of autumn, and the light they emit is to direct them to their food. They feed on small snails, the carcasses of insects, &c. They frequently cast off their skins: after the expiration of about one year and nine months from their birth, they arrive at their perfect size. They then cease to eat, cast off their skin, and assume another appearance. The form of the perfect insect may be discovered through a thin skin that covers them. After remaining in this state two or three weeks, (scarcely ever moving,) they throw off their last skin, and arrive at perfection. The male then appears a perfect beetle, with wings and cover, to the same. The female, on the contrary, has neither wings, nor wing-cases; she is larger than the male, and of a lighter colour. It is the female that principally shines in a perfect state. Her light is far superior to that emitted by the larvæ, and arises from the three last rings of the body on the lower side."* Numerous opinions have obtained on the proximate cause or source of this curious illumination; and several experiments and observations to determine this point will be found collected in a small volume of *Experimental Researches*, by John Murray, F.S.A. F.L.S., &c. We have not space for the details, but quote the corollaries deduced from them by this ingenious observer:

1. Light, as connected with the glow-worm, is a subtle, evanescent principle, perhaps connected with a peculiar organized structure, or attached to a substance circumfused round the vitellula of the ovum, or integrating with it; unsupported by any chemical action, and confinable by the transparent film, or capsule, which imprisons it. 2. This light is perma-

*Phil. Mag. vol. lviii, p. 53.

nent, and independent of any power possessed by the insect over it, except in so far as it can withdraw the luminious matter from the window, or transparent medium, through which it is discerned, burying it in the interstitial matter, or secreting it under an opaque shell. 3. The light is not connected with any of the functions of animal life as to its support or continuance, as with the spiracula, or breathing apparatus, and even the extinction of life itself does not extinguish the power and property of emitting light. 4. The luminous matter is not adherent exteriorly, but included in a capsule, which preserves it from extrinsic agency and contingency. 5. The light seems connected with peculiar organization, which elevated temperatures destroy, perhaps by decomposition, but which low temperatures only suspend temporarily. This very suspension, indeed, by cold, and restoration by warmth, and by a temperature equal to that of animal heat, goes far to prove a peculiar function, *inherent in the capsule*, and capable of educing and sustaining the phenomenon." Mr. Murray thus concludes: "The use to which it is subservient in the animal economy, it is difficult to ascertain—'we see but in part.' Its very existence, however, proves that it is a condition indispensable to its being. Providence has tipt the insect with living fire—a non-material ignition—burning, yet not consumed—even extinguished by a temperature which the animal system, with which it is so singularly interwoven, cannot withstand. It may be a 'lamp to its path,' to guide it to its food, subserving the additional purpose of warding off its enemies—while it may also be the luminous point that directs the nightingale to its proper prey."

Why is the larva of the glow-worm proverbial for its cleanliness?

Because it has an instrument at the tail consisting of white cartilaginous rays, disposed in a circle, one row within another, and retractile similar to the

horns of a snail, which the insect employs for cleansing itself. This contrivance operates by suction, and not as a comb, brush, or wiper, and is furnished with a sort of funnel-shaped pocket, formed by the converging rays, into which are collected dust, &c. from the body, and the accumulated pellet is then extruded, and carefully placed where it might be out of the way of again soiling the glossy skin of the insect. This skin is of a soft leathery appearance; exhibiting, when magnified, a minute delicate dotting, similar to shagreen. The instrument being expanded over this shagreened surface, is drawn out with an evident effort, in the same way as boys draw the moist leather suckers, when they amuse them in dragging stones after them. All dust, &c. is then detached from the skin, and by a peculiar movement of the retractile rays, is lodged in the funnel-shaped pocket. This instrument also assists the animal to walk, and particularly to maintain a position against gravity, which its feet are ill calculated to effect.—*Mr. Rennie, in Journ. Royal Instit.* (*abridged.*)

Why is the lampyris, or fire-fly, so highly prized in India?

Because the Indians believe them to be the spirits of their departed ancestors. Sir James E. Smith informs us that the beaux of Italy sometimes adorn the head-dresses of the belles with these "stars of the earth and diamonds of the night." Mr. Murray also says, "I remember, one fine night, on coming from Arquà (once the residence of Petrarch) to Padua, that the whole trees and hedges, to the very summit, were illuminated with myriads of these living diamonds—the effect was magically magnificent."

Why is the baya bird of India supposed to light his nest with fire flies?

Because he catches the flies at night, and confines them with moist clay or cow dung. Bishop Heber says, "as the light of the flies could be of little use

to the baya, it seems probable that he only feeds on them."

THE SKIPPER.

Why is the skipper so called?

Because of the singular dexterity with which, when lying on its back, it throws itself into the air, and falls on its feet.

Why is the light of the skipper superior to that of the glow-worm?

Because it is emitted from two protuberant, transparent, or windowed tubercles attached to its thorax, besides which there are two luminous spots beneath the elytra, only visible, of course, when it is on wing, and they are elevated: it then appears studded with four rich and vivid gems of a golden, blue lustre. In fact, the whole body seems a flood of pure light. In the West Indies, the natives employ these living fires to give light in managing their household concerns. In travelling, they are wont to attach one to each toe; and it is stated that in fishing and hunting they require no other illumination.—*J. Murray.*

THE EARWIG.

Why is the earwig so called?

Because of its supposed predilection for entering the human ear. Whether or not they ever did enter the human ear is doubtful,—that they might endeavour to do so, under the influence of fear, is more than probable; and this, perhaps, has been the origin of their name, and the universal prejudice against them. As it is said that anatomists deny the possibility of their deep or dangerous entrance into the ear, it is a pity that this is not generally known, as it might defend the constitutionally timid from unnecessary alarm.—*Brande's Journal.*

Earwigs, spiders, bees, and wood-lice, are amongst the few of the insect tribes which pay attention either to their eggs or offspring.

HEMIPTERA.

THE MANTIS.

Why are certain insects termed walking leaves?

Because their wing-cases, not only in colour, but in texture, and even in veining, are so exactly like leaves, from the fresh green of those newly expanded, to the faded brown of those withered and fallen, that botanists themselves might be deceived, if they were detached from the insects, and exhibited as real leaves. Among locusts alone we find the various species with wing-cases resembling, in this manner, the leaves of the laurel, the myrtle, the citron, the lily, the sage, the olive, the camellia, thyme, and grass. The spectres, on the other hand, resemble the small branches of trees with their spray; and so minutely detailed is this mimicry, that the very snags and knobs, as Kirby and Spence remark, are accurately imitated. The caterpillar of the swallow-tail moth also resembles a walking branch, the ringed bulgings of the body being precisely like those of an elder branch, while the longitudinal stripes are like the cracks in the bark.

The mantis of this tribe is found in China and South America, and in the latter country many of the Indians believe that mantes grow on trees like leaves, and that having arrived at maturity, they loosen themselves, and crawl or fly away.

Why is this species also called the religious or praying mantis?

Because it is of slender shape, and in its sitting posture holds up the two fore-legs slightly bent, as if in an attitude of prayer; whence vulgar superstition has held it as a sacred insect; and a popular notion has prevailed, that a child or a traveller having lost his way, would be safely directed, by observing the quarter to which the animal pointed, when taken into the hand.

According to the latest classification, mantes have been divided into the two families of the mantida and

phasmida, founded on a difference in the structure of the foot or leg; this member, in the former, being raptorious, is provided with a sharp claw, and a hollow on the leg and thigh, and a double series of spurs, for the better securing its prey; and in the latter, being destitute of any such peculiarity. One of the species, (*gongylodes*) when alive and fresh, resembles a blade of grass, differing in colour according to the season, being green and succulent in the rains, and in dry weather so much like a withered straw, that it can with difficulty be distinguished. They are very ferocious, and in China the fighting mantis forms as much the favourite amusement of boys, who carry them about in cages for the purpose, as cock-fighting in England.—*Trans. Asiatic Soc. Calcutta.*

THE CRICKET.

Why do we use the simile, "merry as a cricket?"

Because, quitting its summer abode, about the end of August, and fixing its residence by the fireside of kitchens or cottages, the cricket is as merry at Christmas, as other insects in the dog-days.

Herrick, among the pleasures of a country life, quaintly sings to his brother,—

> Yet can thy roof maintain a quire,
> Of singing crickets by thy fire;
> And the brisk mouse may feast herself with crumbs,
> Till that the green-eyed kitling comes.

The grasshopper and cricket race effect their well-known and often wearisome chirpings by grating their spiny thighs against their rigid wings.

LOCUSTS.

Why are locusts the scourge of oriental countries?

Because their devastations are so formidable, as sometimes to cause general scarcity and famine. They have likewise swarmed in Europe. In 1748 they appeared, but did not propagate, in England. In 1650, a cloud of locusts entered Russia, and afterwards

spread over Poland and Lithuania, so as to darken the air and cover the earth, when dead, in some places, to the depth of four feet; the trees bent with their weight. In the year 591, an army of unusually large locusts ravaged Italy, and being at last cast into the sea, (as seems for the most part to be their fate) a pestilence, it is alleged, arose from their stench, which carried off nearly a million of men and beasts. In the Venetian territory, likewise, in 1478, more than 30,000 persons are said to have perished in a famine chiefly occasioned by the depredations of locusts.

Why are these insects called the locusts of scripture?

Because they are the species so accurately described in the Bible. Thus, in Joel ii. 2, &c. "A fire devoureth before them; and behind them a flame burneth: the land is as the garden of Eden before them, and behind them a desolate wilderness: yea, and nothing shall escape them. The sound of their wings is as the sound of chariots, of many horses running to battle; on the tops of the mountains shall they leap, like the noise of a flame of fire that devoureth stubble, as a strong people set in battle array. Before their faces the people shall be much pained; all faces shall gather blackness. They shall run like mighty men; they shall climb the wall like men of war; and they shall march every one in his ways, and they shall not break their ranks; neither shall one thrust another."

Why has so much controversy arisen on "locusts and wild honey," the food of John the Baptist, in the wilderness?

Because the commentators have interpreted the former as the fruit of the cassia-fistula, or locust-tree, resembling tamarinds; and other substitutes. Dr. Clarke, the traveller, was one of the first to propagate this misconception. There is, however, no doubt of the insects being the food, since Hasselquist mentions locusts being eaten by the Arabs, so that probably this

dish was used in the time of St. John. Mr. Forbes, the Oriental traveller, corroborates this account, and adds, "The wild honey is found in the clefts of the rocks of Judea, as abundantly as in the caves of Hindustan."

THE LANTERN FLY.

Why is the lantern fly so called?

Because it emits a strong light from a horny bladder on the head, almost as large as the whole body, so that the natives of Guinea use them as lanterns. The light, according to Mad. Merian, is sufficient to read a newspaper by.

THE FROTH WORM.

Why is white froth so frequently seen in summer on willows, rose-trees, grass, &c.?

Because it is thrown up by the larva of the cuckoo-spit frog-hopper, as a protection from the sun, the creature being exceedingly soft. The name of "cuckoospit" is therefore a popular mistake.

APHIDES.

Why do aphides or plant lice increase so rapidly?

Because one impregnation not only renders fertile the eggs of the individual, but the animals produced from these, and the eggs of these again, unto the ninth generation.—*Philos. Transactions.*

Why are the aphides, so often seen on apple-trees, called white blight?

Because they are lodged upon the limbs of the trees in a hoary and cottony substance, beneath which these wingless creatures prey upon the tree by means of a beak terminating in a fine bristle; this being insinuated through the bark and the sappy part of the wood, enables the creature to extract, as with a syringe, the sweet vital liquor that circulates in the plant, till the tree perishes limb by limb. This insect produces its young alive, forming a cradle for them by

discharging from the extremities of its body a quantity of long cottony matter, which becoming interwoven and entangled, prevents the young from falling to the earth, completely envelopes the parent and offspring, and serves as a vehicle for dispersing the wingless animal in tufts wafted by the winds from tree to tree throughout the whole orchard. When the long cottony vesture is removed, the insects are still enveloped in a fine short downy clothing, to be seen by a magnifier, proceeding apparently from every suture or pore of their bodies, and protecting them in their dormant state from the moisture and frosts of our climate. Mr. Knapp thinks the epithet, 'American blight,' may be correctly applied to this insect, but we have no sufficient authority to conclude that we derived the pest from that country.

Why are aphides never seen in the flower of the rose, although they infest the stalk leaves?

Because of the odour of the flower.

Why are the larvæ of lace-winged flies called the lions of aphides?

Because they devour the latter with great voracity, sucking the juices of their victims with their crescent-shaped and hollow mandibles.

The transparent wings of some insects are so attenuated in their structure, that 50,000 of them, placed over each other, would not form a pile a quarter of an inch in height.

KERMES AND LAC.

Why is the kermes so highly prized?

Because, in the south of Europe, where it is found, on holly, carmine is prepared by sprinkling vinegar on the berry or gall-shaped nests of this animal's eggs.

Why is gum-lac so called?

Because it is the produce of the lac-insect, on the hilly parts of Hindostan. Blumenbach says, "a white

wax-like kind of lac has lately been found in Madras, the specimens of which, in my possession, consist of single cells, resembling coffee-berries in size and shape; it may prove very valuable in India, where bees'-wax is scarce." Although Blumenbach states this as a recent discovery, Dr. Pearson, in 1794, obtained from the same substance, or white lac, a peculiar acid, which he called laccic acid.

Lac appears designed to answer the purpose of defending the eggs of the insect from injury, and affording food for the maggot in a more advanced state.

COCHINEAL INSECT.

Why was the cochineal insect originally supposed to be a grain or seed?

Because, during the whole term of its life, it remains fixed to the spot where it first settled, and to the vegetable nipple of the nopal plant which feeds it.

Why are these insects propagated with such rapidity?

Because the nopal plant is inoculated with them, by being rubbed with a small portion of the young resembling blight, and, in proportion as the plant increases its leaves, it is sure to be covered with this costly parasite. When the plant is perfectly saturated, the cochineal is scraped off with great care. Plantations containing fifty or sixty thousand trees, growing in straight lines, may be seen in some districts of America. The quantity of insects annually exported from South America is valued at 500,000*l.* The Spanish Government are jealous of its being naturalized elsewhere, while a reward of 6,000*l.* is offered by the East India Company for its introduction into our territories.* Cochineal has been transplanted to Java and old Spain, with great success, and on the island of Malta. The wild species of cochineal, or kermes,

* The duty on cochineal imported from British possessions is 2*d.* per lb., other places, 6*d.*, and the amount for the year 1827 was 4,162*l.* 13*s.* 11*d.*

was discovered about three years since among coffee plants and acacias in the Botanic Garden at Cambridge, where the gardeners called them "amelca bugs."

Why are the female insects the most valuable?

Because they produce the best colour. They are in number to the males as three hundred to one. M. M. Pelletier and Caventou have lately found that their very remarkable colouring matter is mixed with a peculiar animal matter, like fat, and with different salts: they have obtained this colouring matter in great purity and called it *carminium*. Carmine is a triple compound of an animal matter, carminium, and an acid which enlivens the colour.

Why is fine cochineal of a gray colour, inclining to purple?

Because the gray is a powder which covers it naturally, a part of which it still retains; and the purple tinge proceeds from the colour extracted by the water in which it has been killed.

The important use of cochineal in producing a fine scarlet colour, is now well known. Long after its introduction, however, cochineal gave but a dull kind of crimson, till a chemist named Kuster, about the middle of the sixteenth century, discovered the use of the solution of tin, and the means of preparing with it and cochineal, a durable and beautiful scarlet. The immense consumption of cochineal in England is, in some measure, explained by the prevailing colour of our army clothing being scarlet.

LEPIDOPTERA.

BUTTERFLIES AND MOTHS.

Why do butterflies often fly circuitously?

Because one sex pursues through the air the track of the other.—Butterflies also migrate in immense

swarms. M. Hubert relates the flight of a column of them in Switzerland, about four years since, the passage of which lasted upwards of two hours, and extended in breadth from ten to fifteen feet. He also describes their flight as low, rapid, and equal.

Why are butterflies believed to explain the showers of blood recorded by superstitious historians?

Because many of these insects when evolved from the pupa state, void a red-coloured matter resembling blood. Mouffet tells us, from Sleidan, that in the year 1553, a prodigious multitude of butterflies swarmed throughout a great portion of Germany, and sprinkled plants, leaves, buildings, clothes, and men, with bloody drops, as if it had rained blood. Several historians, indeed, have recorded showers of blood among the prodigies which have struck nations with terror, as the supposed omen of the destruction of cities and the overthrow of empires. The error was first detected by M. Peiresc, a philosopher, of Aix, who, at the time of a rumoured shower of blood, happened to have a large chrysalis in a box, which, changing into a butterfly, left a red stain of the same nature with the drops of the shower popularly supposed to be blood.

Why is the humming-bird hawk-moth so called?

Because of its vigilance and animation, equal to the splendid meteoric bird of the tropics, and not on account of its resemblance in colour; since our plain and dusky insect has none of the glorious hues of the bird. The least movement alarms this moth; though Nature seems to have given it some essential requisites for its safety. Its activity, when on the wing, renders its capture difficult, and when it rests, it is on a wall, the bark of trees, &c.

Why is the Atropos moth so called?

Because of its origin from *Atropos*, the third Fate, it being a great destroyer of bees.

Why did Linnæus call the small tortoiseshell-butterfly "the deceptive herald of spring"?

Because there often appear, on fine days, individuals which have survived the winter.

Why is the atlas-moth so called?

Because of its immense wings, larger than those of a common bat; the body is, however, remarkably small.

In a Madras Journal, date 1829, we read of a person at Arracan who caught a moth which measured from the tip of one wing to the tip of the other, ten inches. Both wings are beautifully variegated with the brightest colours. The editor thinks this the largest moth on record, exceeding in dimensions the largest in the British Museum, which measures about nine inches from tip to tip.

Why is the goat-moth so called?

Because it emits a peculiarly subtle smell, which has been thought to resemble that of the goat. The object and seat of this odour seem not well understood. Some have conjectured it to proceed from the mouth, and discharged to soften the wood in which it burrows: the latter opinion is not, however, tenable, as many other insects that perforate timber, are not so supplied, and the microscope does not manifest the exudation of any fluid.

Why is the gamma-moth so called?

Because it has imprinted on its dark wings a white character, something like the letter Y, but more like the small Greek *gamma*.

Why is the large white-moth used by anglers callea the miller's fly?

Because of the mealy substance about its wings and body.

Why is the death's-head moth so called?

Because of the markings of its back being supersti-

tiously associated with the head of a skeleton, with the limb-bones crossed beneath. In German-Poland, this moth is called the death's-head phantom, the wandering death-bird, &c. Its cry, produced by scratching its mandible against its horny chest, there becomes the voice of anguish, the moaning of a child, the signal of grief; it is regarded as the device of evil spirits, and the very shining of its eyes is thought to represent the fiery element whence it is supposed to have proceeded. Flying into the apartments of weak persons, in the evening, it at times extinguishes the light, foretelling war, pestilence, hunger, death—to man and beast.

Why is the ghost-moth so called?

Because of its singular flight in the twilight hour, haunting, as it were, one particular spot—wherefore the fancy of some collector probably considered it a spectre-like action.—*Knapp.*

Why is the ghost-moth distinguishable from all others by its continued flight over one spot?

Because it thus woos its mate, lying concealed in the herbage over which it sports.—*Knapp.*

Why is the male ghost-moth supposed to be destroyed in such numbers by nocturnal birds?

Because his white satiny wings are easily discerned in the twilight, and these wings are frequently found scattered about in our morning walks.

Why are the caterpillars of the swallow-tailed-moth called surveyors, loopers, and geometers?

Because of their peculiar manner of moving, which may readily be conceived by those who have not seen them, when we mention, that at the commencement of each step their bodies present a pretty exact figure of the Greek letter Ω. In this position, laying hold with their hinder prolegs, they stretch out their heads to the full extent of their body, laying hold with their fore-legs while they again bring forward their body into the shape Ω again.

THE SILKWORM.

Why does the silkworm spin a silky cocoon?

Because it may therein change from the caterpillar to the pupa state in greater safety. This cocoon it prepares from a gum or tenacious fluid contained in two pouches, placed along the back, beneath the stomach; which fluid it spins into very fine threads, by means of a particular tube placed behind the mouth. It is the middle portion of the cocoon, after removing the floss or loose silk on the exterior, which is used in our manufactories.

Why is the first preparation of silk to throw the cocoons into warm water?

Because it may dissolve any slight adhesions which may have occurred when the caterpillar was spinning.

Why is it evident that the insect spins the whole without interruption?

Because the cocoons may be generally unwound without breaking the thread. It is popularly supposed, however, that if the insect be disturbed during the operation by any sort of noise, it will take alarm, and break its thread; but Latreille says this is a vulgar error. The length of the unbroken thread in a cocoon varies from 600 to 1,000 feet; and as it is all spun double by the insect, it will amount to nearly two thousand feet of silk, the whole of which does not weigh above three grains and a half. Five pounds of silk from ten thousand cocoons is considerably above the usual average. When we consider, therefore, the enormous quantity of silk which is used at present, the number of worms in producing it will almost exceed our comprehension.

Why is it requisite to devote whole plantations of mulberry-trees to the culture of silkworms?

Because of the voracity of the animal,—a single caterpillar weighing, when first hatched, only the hundredth part of a grain—consuming, in thirty days, above an ounce of leaves; that is to say, it devours in

vegetable substance about 60,000 times its primitive weight.

Count Dandolo, in his recent *Treatise on Silkworms*, thus estimates their progressive increase in weight:

	grains.
100 worms, just hatched, weigh about - - -	1
After the first moulting - - - - - - -	15
After the second moulting - - - - - -	94
After the third moulting - - - - - - -	400
After the fourth moulting - - - - -	1,628
On attaining their greatest size and weight - -	9,500

They have, therefore, in thirty days, increased 9,500 times their primitive weight. The length of the silkworm also increases about forty times in twenty-eight days. Again, the Count calculates that the quantity of leaves drawn from the tree employed for each ounce of eggs, amounts to 1,609 lb. 8 oz.

In France, the scorzonera, or *salsifis*, has been advantageously substituted for the mulberry in rearing silkworms. The silk produced is equal to that of the worms fed upon mulberry leaves, and surpasses that obtained from worms fed upon lettuce-leaves; in the latter case, the quantity has been doubled.

To prevent the jaundice common among silkworms, the Abbé Esseric, of Carpentras, used to powder them with quick-lime by means of a silk sieve; he then gave them mulberry-leaves moistened with a few drops of wine. It was at first supposed that the cocoons of silk were injured by this process; this, however is not the case, and his method is now adopted generally in the department of Vaucluse in the south of France.

Why has it been inferred that silk is a vegetable, not an animal product?

Because part of the interior of the white mulberry, upon which silkworms thrive best, is composed of a tissue of beautiful white silky fibres, much resembling China silk: hence, the basis of the material, in its proximate form, is derived from the vegetable kingdom, though the spinning of its substance into a length-

ened thread is entirely due to the mechanical functions of the silkworm.

The growth of the silkworm has been tried, but with no great success, in this country. Evelyn computed that one mulberry-tree would feed as many silkworms annually as would produce seven pounds of silk. "According to that estimate," says Barham, (dated 1719,) "the two thousand trees already planted in Chelsea Park, (which take up one-third of it) will make 14,000 lb. weight of silk; to be commonly worth twenty-shillings a pound, those trees must make £14,000 per annum."

Why do silkworms in warm climates consume a rather less quantity of leaves?

Because the leaves are supposed to be more nutritive; but, in that case, the silk produced is not so delicate and fine.

Of the kind and size of the silkworm also is the Sustillo, a caterpillar bred in the pacae, a tree well known in Peru.' When completely satiated with the leaves, it spins a *fine silk paper*, which has been gathered measuring a yard and a half in length. In proportion to the vigour and majestic growth of this tree is the number of insects it nourishes.

Why is silk manufacture one of the most important of commercial resources?

Because the labour in preparing new silk affords much more employment to the country producing it, than any other raw material. The fact has been established before a committee of both Houses of Parliament. We may add, that the raw silk imported into England, from all parts of the world, in 1814, amounted to one million six hundred and thirty-four thousand, five hundred and one pounds; and in 1824, to three millions, three hundred and eighty-two thousand, three hundred and fifty-seven. The official values of these imports are £703,009, and £1,464,994.

Why was the manufacture of silk, in ancient times, confined to the East Indies and China?

Because the insects that produced it were indigenous to those countries. It was thence brought to Europe in small quantities, and in early times sold at so extravagant a price, that it was deemed too expensive even for royalty.

Why were silk-dresses prohibited by Mahomedans?

Because they considered silk unclean, from its being produced by a worm. Hence it was decided that a person wearing a garment made entirely of silk, could not lawfully offer up the daily prayers enjoined by the Koran.—*Herbelot.*

The history and economy of the silkworm would occupy some score pages, but these few facts are the latest illustrations.

Why are the eggs of some insects found strongly cemented round the twig of a leafless tree?

Because they may there survive the winter, and be hatched in spring; the living principle, though not in a state of activity, being capable, as it would appear, of withstanding severe cold.

Why do these caterpillars hang by a thread of silk from the branches of trees, with their head downwards?

Because they may be always ready to drop down in safety, by extending this thread, on the sudden approach of their enemies.

THE COSSUS.

Why is the cossus so destructive to the trees on which it lives?

Because it exists as a caterpillar three years previous to its changing into the pupa state. It is so tenacious of life, that it will remain in an artificial vacuum for hours together, without being injured; and under water for almost three weeks in the middle of summer. It is remarkable also, that the pupa has the power of

locomotion, and when the time of its change approaches, can bore its way from the middle of the tree to the bark.—*Blumenbach.*

Why has the caterpillar of the cossus been stated by entomologists as a specimen of the muscular strength of insects?

Because it contains more than seven times as many muscles as the human body, being 4061. Lyonnet has ably illustrated the anatomy of this extraordinary creature. Mr. Rennie put one of these caterpillars under a bell-glass, which weighed nearly half-a-pound, and upwards of ten times the weight of the insect, yet it raised it up with the utmost ease. He then placed on the glass a thick book, weighing four pounds, and the animal again raised the glass, though loaded with the book, nearly a hundred times its own weight, and made good its exit. It should, however, be mentioned, first, that the wedge-like form of the caterpillar's head, in connexion with the peculiar shape of the glass, enabled it to lift it; and, secondly, that one side of the glass resting on the table, the insect only bore half the weight of the glass and book.—*Insect Transformations.*

NEUROPTERA.

THE DRAGON-FLY.

Why are the larger dragon-flies usually called horse-stingers?

Because they are supposed to have a propensity to sting horses, and (it may be presumed) any other animal which may irritate them. But, *not one of the tribe is furnished with a sting.* They have, however, a pair of most formidable looking jaws, though even these are not strong enough to inflict injury upon any of the larger animals, and are only employed to crush a fly, or to wing a moth or a butterfly.

We may here mention that the larvæ of the dragon-

fly are provided with an apparatus probably unmatched in the insect world. This consists of a *mask*, or the under lip of the larva, which conceals the mouth and face, and two plates covering the jaws. While this strange organ is at rest, it applies close to and covers the face. When the insects would use it, they unfold it like an arm, catch their prey by means of the plates, which are toothed like jaws, and then partly refold the lip, so as to hold the prey to the mouth. De Geer observes, the larvæ of the dragon-fly do not, however, trust to this *mask* alone, for surprising their prey, but steal upon it, as a cat does upon a bird, very slowly, and as if they counted their steps; and then, by suddenly *unmasking*, seize it by surprise: so artful are they, that insects, and even small fishes, find it difficult to elude their attacks.

Why do the larvæ of dragon-flies suck in and eject water to aid their progress in swimming?

Because the jet propels the creature through the water, in consequence of its being resisted by the stationary mass of the fluid behind it, and a contrary current being thence produced by this singular pumping. As the insect, between every stroke of the internal piston, is obliged to draw in a fresh supply of water, an interval consequently occurs between the strokes, during which it will sometimes elevate its tail above water, and squirt out a small stream like that from a little syringe. Among other purposes of this wonderful apparatus are its aid in bringing small water insects within its reach, and its share in respiration, in which it somewhat resembles the gills of fish.

THE DAY-FLY.

Why is the ephemera or day-fly so called?

Because it lives but a very short time in its perfect state; often only for a few hours. Day-flies live in water some years as larvæ. After that time, in many

places, millions of the perfectly-formed insects make their appearance from the water, within a few days, in the middle of summer; they then also, contrary to what happens to other insects, cast their skin again.—*Blumenbach.*

Why are water-flies less abundant than formerly?

Because of the diminution of rivers and streams, and the cultivation of the country. "Thus," observes Sir H. Davy, in his *Salmonia*, "most of the bogs or marshes which fed considerable streams are drained; and the consequence is, that they are more likely to be affected by severe droughts and great floods; the first killing, and the second washing away, the larvæ and aurelias. May-flies, thirty years ago, were more abundant in the upper part of the Teme river, in Herefordshire, where it receives the Cluer; they are now seldom or rarely seen; and most of the rivers in that part of England, as well as those of the west, with the exception of those that rise in the still uncultivated parts of Dartmoor and Exmoor, are often rapid and unfordable torrents, and in dry summers little more than scanty rills."

THE CADDIS.

Why does the caddis-worm, or larva of the water-moth, encase itself with shells, stems, leaves, straws, &c?

Because its form is but little adapted for swimming: its long body, encumbered with six legs, is specifically heavier than water, the element in which it has to seek its food; and it thus attaches itself to these bodies, to counterpoise its own excess of gravity, and enable it to swim on the surface, in the centre, or at the bottom of the water. This explains the variety and singularity in the materials of the coats of these insects. When they want to ascend, the quantity of hollow and buoyant substances attached to them is increased; in order to descend, the light and hollow substances are either diminished or counterpoised by an addition of heavy materials, such as shells or gra-

vel; the interior they line with a fine silk spun by themselves.

HEMOROBIUS.

Why does the hemorobius perla fasten its eggs to the leaves of trees, upon upright bristle-like points?

Because the aphis has previously laid its eggs upon these leaves, and the young aphides would destroy the above eggs, were they not thus kept out of their reach. As soon as the larvæ of the hemorobius appear, they crawl down the slender props upon which they rested, and commence devouring the aphides, wherefore the former are termed plant louse lions; and by thus thinning them, they are doubtless of great service in the general economy of nature.

ANT-LION.

Why is the ant-lion so called?

Because, when in its larva state, it digs, with its leg for a shovel, a funnel-shaped pit in the sand, and covers itself up to the neck, laying wait for and destroying the ants and other small insects, which, not perceiving it, come to the edge of the pit, and slip in over the loose sand. Like its prototype, the lion, it will not take a dead animal, however recently killed; and those insects who simulate death when danger is near, escape the fangs of the ant-lion.

HYMENOPTERA.

GALL INSECTS.

Why are "apples" produced on oak-trees?

Because the female gall-fly lays her eggs in the buds, which consequently swell, and the excrescences serve for the abode of the larva until it has completed its changes, and is in a state to issue from its prison; after which the apples often become the residence of various kinds of wasps.

Why are oak-apples filled with fibres in the direction of the stem?

Because the gall-fly has thus diverted the nervures of the leaves, which would have sprung from the bud in which the eggs were inserted, and actually do carry sap-vessels throughout the substance of the gall.—*Reaumur.*

Blumenbach says, that each egg grows in size after it has been deposited in the plant, and sometimes doubles its size before the larva issues from it.

The excrescences on the leaves of the rose-tree, the oak, the poplar, the willow, and other trees, are also formed by the gall-fly depositing its eggs there; The gall-nut used in making ink is similarly produced. Those on the currant-leaf are produced by aphides.

Why are cultivated figs ripened by being suspended beneath wild ones?

Because the wild figs are full of gall insects, which becoming winged, quit the same, and penetrate the cultivated ones to lay their eggs: the insects appear to ensure the fructification by dispersing the pollen, and afterwards to hasten the ripening by puncturing the pulp, and causing a dispersion or circulation of nutritious juices. This is called *caprification*, and in France is imitated by inserting straws dipped in olive oil.

THE ICHNEUMON FLY.

Why do ichneumon flies materially contribute to the destruction of caterpillars, spiders, &c.?

Because they lay their eggs in living caterpillars, which consequently become diseased, and die either before or after their change into pupæ.

Why do these flies preserve crops of wheat?

Because they destroy the wheat insects, and for this purpose may be found round the corn-ear all the day.

These flies appear of great self-denial and curious fancy; for they only lay an egg beside an egg of the wheat-fly, which is hatched along with it, devours it, and saves the wheat. The most abundant species of

these ichneumons, or flies of prey, positively lays its eggs in the very body of the yellow maggot, while it is feeding busily. It has a long hollow rod, projected at pleasure from its tail, which it thrusts at pleasure into the body of the worm, and down which it then sends one egg from its body, which egg is hatched within the body of the maggot, and consumes it.—*Quarterly Journal of Agriculture.*

THE WASP.

Why are there usually two holes in the outer walls of a wasp's nest?

Because they may serve as the gates of the city; according to Reaumur, one of them is for ingress and the other for egress; and such is the order observed, that the uses of the respective doors are rarely if ever changed. The cells of the nest or vespiary, are solely constructed to lodge the young, and on an average a nest may contain about 16,000 cells, which are filled thrice in each year.

Years productive of the plum are said to be congenial likewise to the wasp. A local rhyme will have it,

> When the plum hangs on the tree,
> Then the wasp you 're sure to see.

Why is the wasp supposed to seize flies rather in wantonness than for food?

Because it bears the fly about with it for a length of time, and drops it unconsumed.

Why is a wasp of Guadaloupe termed "vegetating?"

Because it is united to a living plant, so that when the insect attempts to rise from the nest, it falls to the ground, on account of the weight of the plant, which takes root on some part of the body, particularly on the breast-bone. It was long thought that these plants grew on insects deprived of life. M. Ricord has, however, determined otherwise, and has observed that the larvæ in the cells also have this vegetating appendage, but then it is very small.—*Journal de Pharmacie.*

THE HORNET.

Why is the hornet so fatal to wasps?

Because it not only seizes the wasps while feeding, but hawks after them when on the wing. Having captured them, the first operation is to snip off the head, then to cut away the lower part by the waist. Sometimes you may hear the hornet shearing away the outer coat from a wasp's body, and crushing it with its strong mandibles; sometimes devouring it, but generally only sucking the juices it contains.

Why are hornets supposed to fall victims to each other's voracity towards the end of autumn?

Because they fight desperately when they meet in pursuit of prey, biting each other's body, and trying to get their mandibles under the head of their opponents, to snip it off. Pairs of them often die after such a contest.

BEES.

Why are bees the most persecuted of insects?

Because every living thing, from man down to an ephemeral insect, pursues the bee to its destruction for the sake of the honey that is deposited in its cell, or secreted in its honey-bag. To obtain that which the bee is carrying to its hive, numerous birds and insects are on the watch, and an incredible number of bees fall victims, in consequence, to their enemies. Independently of this, there are the changes in the weather, such as high winds, sudden showers, hot sunshine; and then there is the liability to fall into rivers, besides a hundred other dangers to which bees are exposed.

The average number of a hive, or swarm, is from fifteen to twenty thousand. Nineteen thousand four hundred and ninety-nine are neuters or working bees, five hundred are drones, and the remaining *one* is the queen or mother!

Why are the antennæ of bees supposed to be their organs of touch?

Because these organs alone enable the bee to work in the darkness of the hive.

Why are "hummings in the air" sometimes heard in sultry weather?

Because a collection of bees, or some such insects, are high in the air, although the musicians are invisible. Mr. Knapp describes these as "the humming of apparently a large swarm of bées."

Why do bees build in hives?

Because they have been thus domesticated by the ingenuity of man. In the wild state they build in hollow trees, under ground, &c.

Why does honey differ from wax?

Because honey is a simple substance, extracted by bees from the flower; whereas, wax is a secretion found in scales under their belly. The wax-workers, having gorged themselves with the nectar of flowers, hang motionless in festoons in the hive; and in twenty-four hours, scales of a white matter, like talc, are formed under the ring of the abdomen. The wild honey of Palestine has already been noticed at page 254.

Why is the stomach of the bee called the honey-bag?

Because in it the nectar of the flowers is elaborated and converted into honey. The animal vomits it up from this reservoir, and deposits it in the hive.

Why does the quality of honey vary in different hives?

Because the sense of taste in bees is so unrefined, that it matters little to what neighbourhood some go to gather honey, or from what flower. Dr. Barton, in the *American Philosophical Transactions*, enumerates such plants as yield a poisonous syrup, of which bees partake without injury, but which has been fatal to man.

Why are bees so fond of the peach-tree?

Because they not only drink the nectar, and abstract the pollen of the flower, but they appropriate the peach

itself. An American writer says, "we have seen twenty or thirty bees devour a peach in half-an hour; that is, they carried the juices of it to their cells."

Why is it improbable that bees are affected by the hiving-pan, or a tin-kettle?

Because their sense of hearing is very obtuse. Huber says, that "thunder, or the report of a gun, has little or no effect upon them. Sounds are, however, made by the flapping of the wings and other movements of the body, which are distinctly heard and understood by bees. Their sense of smelling is, doubtless, acute."

Why do bees build their cells of a six-sided form?

Because it is one of the only three figures by which a space can be filled with cells, without leaving any space between them; and is the most convenient and the strongest, except the circle, by which some room would be lost. By the six-sided form, therefore, the bees save both space and materials.

Why do the walls of bee-combs appear double and treble?

Because the larvæ are not content with the cells as a covering during the pupa state, but they line their sides and bottom, and cover their mouth with silk, thus making a complete cocoon. These, after the insect has been perfected, are left in the cell, and when it contains another larva, a second lining is prepared. Each lining at the bottom, in the bee, covers the excrement, which the animal had produced in its larva state. John Hunter, by whom the above appearance was observed, has counted twenty different linings in one cell.

Why are certain bees called carpenters and masons?

Because the former work in wood, as the latter do in bricks, &c.

The mason builds its nest with wonderful art and strength, of the sand and mortar of old walls exposed to the sun.

Within this are chambers lined with leaves, and containing one egg, which, becoming a maggot, lives on the store provided by the mother, changes to a chrysalis, and comes forth a perfect insect in the following spring.

Why are others called upholsterers?

Because they construct their abodes by cutting off portions of the leaves or bark of plants, and uniting them with silk, &c. Even the most elaborate skill of art and luxury cannot excel the embellishments of the cells of these bees. The rose-leaf-cutters are of this species.

Why are others called tapestry-bees?

Because their exclusive business is to adorn the chambers with tapestries of the leaves of flowers, as the poppy, which affords a splendid scarlet hanging equal to the most superb damask.

Why are carder-bees so called?

Because they *card* or prepare moss as wool for their nests.

Why do bees rest in clusters or festoons?

Because four or five cling to a part of the hive, and extend their hind-legs, whence others suspend themselves by their fore-feet, and so on for other lines.

Why is it whimsical to save bees when their honey is taken?

Because they must be fed; and if saved, they will die of old age before the next fall; and though young ones will supply the place of the dead, this is nothing like a good swarm put up during the summer.

This is Mr. Cobbett's opinion. If saving the bees be whimsical, it is harmless; and it is better to be whimsical than cruel.

Why is it important to unite hives of bees for keeping?

Because it has been ascertained that when two or three distinct hives are united in autumn, they consume

together scarcely more honey during the winter than each of them would have consumed singly, if left separate.—*Bee Preserver, translated from the German.*

Why is it evident that all the operations of a swarm of bees are dictated by previous concert and the most systematic arrangement?

Because of their precaution in reconnoitring the situation where they intend to establish their new colony or swarm from the parent hive. The bees do not go out in a considerable body, but they succeed each other in going and returning, until the whole of the swarm have apparently made good the survey, after which the whole body depart in a mass. If, by any chance, a large portion of a swarm take their departure without the queen-bee, they never proceed to take up their ulterior quarters without her majesty's presence.

These interesting facts were lately observed and communicated to the Royal Society, by Mr. T. A. Knight, president of the Horticultural Society.

Why should all bee-stocks be examined before the approach of winter?

Because the gnats or maggots form a chrysalis so strong in the hive, that the bees cannot displace them, and in the spring they creep out of their little sepulchres, and spin a thin web before them, as they march up into the hive among the combs; the bees, endeavouring to dislodge them, are entangled in the web, and there die; and thus, for the want of a little trouble, many stocks are destroyed.

Why should the thatch cap on a beehive be changed often?

Because the straw soon begins to get rotten; then insects breed in it, its smell is bad, and its effect on the bees is dangerous.

Why do bees, when they swarm, fly towards trees?

Because they like the pure air of the higher regions better than the air enclosed in hives, which receive

the exhalations of the earth, and in which contagious diseases make great ravages. Thus, in Livonia, bees are cultivated in forests, and are never known to swarm towards the gardens.

Why is the best situation of a bee-house a little to the west of the south?

Because the sun, shining into the mouth of the hive too early, calls the bee abroad before the cold steam is exhaled from the flowers, and the vernal juice turned into honey; but, in the above situation, the sun will reach the front of the house about nine o'clock.

Why are bevering moths so fatal to bees?

Because they lay their eggs at the mouth of the hive, and, with the wind of their wings, fan them within the hive, where the warmth of the bees hatches them to their own ruin.

Why is it disadvantageous to rub the inside of a hive with herbs, &c. previous to the swarm being put in?

Because it gives much unnecessary labour to the bees, as they will be compelled to remove every particle of foreign matter from the hive before they begin to work. The vile practice of making an astounding noise with tin pans, or kettles, when the bees are swarming, is also utterly useless. It may have originated in some ancient superstition, or it may have been the signal to call aid from the fields to assist in the hiving. If harmless, it is unnecessary; and every thing that tends to encumber the managment of bees, should be avoided.—*American Work.*

Why do weak-minded persons inform bees of any death that takes place in a family?

Because the disastrous consequrence to be apprehended from non-compliance with this strange custom, is, that the bees will dwindle and die. The manner of communicating the intelligence to the little community, with due form and ceremony, is this: to take the key of the house, and knock with it three

times against the hive, telling the inmates, at the same time, that their master or mistress, &c. (as the case may be) is dead! Mr. Loudon says, when in Bedfordshire, lately, we were informed of an old man who sang a psalm the previous year in front of some hives which were not doing well, but which, he said, would thrive in consequence of that ceremony.

ANTS.

Why is the alleged providence of ants more valuable as a moral lesson than for its fidelity to nature?

Because, so far from ants storing up corn for winter provision, no species of them even eat grain, or feed in the winter upon any thing. Again, wood-ants, when within reach of a corn-field, often pick up grains of wheat, barley, or oats, and carry them to the nest as building materials, and not for food, as was believed by the ancients, who also mistook their eggs, larvæ, and pupæ for hoarded grain. Such is the care with which they guard and attend their pupæ, that a working ant has been known to drag ten pupæ into a place of security, after the posterior of its body had been cut off.—*Blumenbach.*

Mr. Carpenter happening once to beat down a number of aphides out of a stunted oak-tree, at the foot of which there was an ant's nest, soon afterwards saw the ants carrying up the aphides, and carefully replacing them upon the leaves of the tree.

Why are the working ants so called?

Because they make, defend, and repair their dwellings, provide their food, watch and attend to the female, and take care of her eggs; they likewise acquire and defend aphides and cocci, which bear to them the same relation that cattle do to man, and which are fed by them with so much care, and the milk of which forms so important a part of their food; they also make predatory excursions to carry off pupæ, which they bring up as slaves.—*Sir H. Davy.*

Black or jet ants occasionally appear in incalculable swarms and singular form, like columns ascending and descending, twenty of which may sometimes be seen together, and at a distance appear almost like an Aurora Borealis.—*Blumenbach.*

Why are white ants so destructive to trees?

Because they are furnished with an acid for softening wood, the odour of which is extremely pungent. They prefer the wood nearest to the bark, which they are careful not to injure, as it affords them protection.—*Latreille.*

Why are the ravages of white ants much more fatal than apparent?

Because they hollow out wood with such nicety, that they leave the surface whole, after having eaten away the inside. A shelf or plank, thus attacked, looks solid to the eye, when, if weighed, it will not outbalance two sheets of pasteboard of the same dimensions. In this manner, too, they hollow out large decaying or fallen trees, leaving little more than the bark.

Why are the houses of termites, or white ants, sometimes mistaken for villages?

Because they are conically shaped, built of clay, generally with several points, arched internally, often ten or twelve feet high, and in great numbers. In time, these ant-hills become overgrown with grass, and so firm as to bear the weight of several men, although the walls are perforated by large wide passages, sometimes more than a foot in diameter. The cells of the king and queen, in each hill, are concealed in its remotest parts. Next to these are the habitations of the workers; then follow the egg-cells for the young brood, and close to them the magazine. The queen can lay 80,000 eggs within twenty-four hours.

Mr. Carpenter once turned the destroying powers of a termes to account in making some delicate dissections

for the microscope. Having placed one in a pill-box with the heads of three dead flies, he found sometime after, that they had completely cleared the interior of some of the eyes from all the blood-vessels, leaving the lenses in the cornea most beautifully transparent.

Why are "monstrous ants in India, as large as foxes," described by old Greek writers?

Because the termites there rear such stupendous fabrics, as certainly might be supposed to be the work of a much larger animal than their real architect. Were our houses built according to the same proportions, they would be twelve or fifteen times higher than the London monument, and four or five times higher than the pyramids of Egypt, with corresponding dimensions in the basements of the edifices.

DIPTERA.

THE HOUSE-FLY.

Why are flies continually brushing themselves with their feet and legs?

Because by this means they rub off the dust, and clean their eyes, head, corslet, and wings,—and to enable them to do this, their foot closely resembles a currycomb. Thus, in the common blow-fly, there are two rounded combs, the inner surface of which is covered with down, to serve the double purpose of a fine brush, and to assist in forming a vacuum, when the creature walks on a glass, or on the ceiling of a room. In other flies, there are three such combs on each foot. The insects are pretty thickly covered with hair, and the serratures (or teeth) of the combs free them from entanglement and dust. Even the hairs on the legs themselves are similarly used; for, flies not only brush with the extremities of their feet, where the curious currycombs are situated, but use part of their legs in the same way, particularly for brushing one another.—*Mr. Rennie, in Journal of the Royal Institution.*

Why is the dogs'-bane so fatal to flies?

Because of the elasticity of the filaments of the plant, which close and catch the fly the instant the trunk is protruded to feed on the expanded blossom: the poor prisoner struggles till exhausted to death, the filaments then relax, and the body falls to the ground. The plant will at times be dusky from the number of imprisoned wretches.

APTERA.

THE FLEA.

Why has the flea been quoted as an instance of insects excelling in muscular power, in proportion to their diminutiveness?

Because it has been known to draw 70 or 80 times its own weight, resist the ordinary pressure of the fingers in our endeavours to crush it, and leap two hundred times its own length. Hence it is called by the Arabians, "the father of leapers." Supposing the same relative force to be infused into the body of a man six feet high, he would be enabled to leap three times the height of St. Paul's.

The feats of fleas drawing golden chains and coaches have been authenticated. Latreille tells us of a flea which dragged a silver cannon twenty-four times its own weight, mounted on wheels, and was not alarmed when this was charged with gunpowder, and fired off.

SPIDERS.

Why do some spiders rest in the centre of their webs?

Because the outstretched cordage may warn them of the temporary entanglement of their prey, on which they instantly rush, and devour, after the infliction of a mortal wound. Many lie in wait beneath leaves, and others spin comfortable tunnels, or watch-towers, as they may be called, in which they repose till the vibration of their nets below calls them into active service.

Why do other spiders spin no webs at all?

Why are scorpions killed by covering them with oil?
Because their respiration is thus prevented.

CRAB, LOBSTER, &C.

Why do not the crab and lobster appear "thin," when ill fed?

Because the stomach is formed on a bony apparatus, in short, a species of skeleton; and does not therefore collapse when empty. Hence the policy of choosing crabs and lobsters by their weight.

Why is the food of the crab and lobster sure to be perfectly masticated?

Because to certain parts of the bony structure of the stomach, round its aperture communicating with the small intestines, (or the pylorus) the teeth are affixed. They are extremely hard, and serrated, or jagged, and as they surround the tube near the pylorus, nothing can pass that has not been duly prepared. These bones and teeth (the latter three in number) are moved by peculiar muscles, and in the craw-fish are known to be annually reproduced.

Why do some crabs attach, by a glutinous matter, the leaves of sea-weeds to their body?

Because they may thus completely conceal their form, and secure themselves from the detection of their enemies.

Why are the two calcareous concretions (commonly called crabs' eyes), found in summer at both sides of the stomach of the craw-fish?

Because they furnish the principal materials from which the new shell is hardened. Some are naturally red, whilst others remain black, even when boiled; and some reach the age of twenty years.

END OF ZOOLOGY.

KNOWLEDGE FOR THE PEOPLE:

OR THE

PLAIN WHY AND BECAUSE.

PART X.—ARTS AND MANUFACTURES.

ARTS AND MANUFACTURES.

INTRODUCTORY.

Why have commerce and the arts an indirect influence upon industry?

Because it signifies nothing as to the main purposes of trade, how superfluous the articles which it furnishes are;—whether the want of them be real or imaginary:—whether it be founded in nature or in opinion, in fashion, habit, or emulation;—it is enough that they be actually desired and sought after. Flourishing cities are raised and supported by trading in tobacco; populous towns subsist by the manufactory of ribands. A watch may be a very unnecessary appendage to the dress of a peasant, yet if the peasant will till the ground in order to obtain the watch, the true design of trade is answered; and the watchmaker, while he polishes the case, or files the wheel of his machine, is contributing to the production of corn as effectually, though not so directly, as if he handled the spade or held the plough. Tobacco is an acknowledged superfluity, and affords a remarkable instance of the caprice of human appetite; yet, if the fisherman will ply his net, or the mariner fetch rice from other countries, in order to procure to himself this indulgence, the market is supplied with two important articles of provision, by the instrumentality of a merchandise which has no other apparent use than the gratification of a vitiated palate.*—*Paley.*

* We should here remark however, that where false refinement, or a corrupted taste, engages that time and ingenuity of the laborer or the artist, which might otherwise have produced articles that contribute to rational enjoyment, it is an evident *misapplication* of industry.

Why does commerce at the same time supply an endless variety of new productions, and multiply and cheapen those that are peculiar to every country?

Because it enables each separate people to employ themselves in preference in those departments in which they enjoy some natural or acquired advantage, while it opens the markets of the world to their productions. When the demand for a commodity is confined to a particular country, as soon as it is supplied, improvement is at a stand. The subdivision and combination of employments are, in fact, always dependent upon, and regulated by, the extent of the market. Dr. Smith has shown, that by making a proper distribution of labour among ten workmen, in a pin manufactory, 48,000 pins might be produced in a day; and since his time the number has been nearly doubled.

Before pins were manufactured in England, £60,000 annually is said to have been paid for them to foreigners in the early years of Queen Elizabeth; but, long before the end of her reign, they were manufactured in this country in great quantities.

The subdivision of the mechanism of a watch into 150 branches has already been cursorily mentioned.* The fifteen principal branches are: 1. The movement maker, who divides it into various branches; viz. pillar-maker, stop stud-maker, frame-mounter, screw-maker, cock and potence-maker, verge-maker, pinion-maker, balance-wheel-maker, wheel-cutter, fusee-maker, and other small branches. 2. Dial-maker; who employs a copper-maker, an enameller, painter, &c. 3. Case-maker; who makes the case to the frame, employs box-maker, outside case-maker, and joint-finishers. 4. Pendant-maker; (both case and pendant are sent to the Goldsmiths' Hall to be marked.) 5. Secret-springer and spring-liner; the spring and liner are divided into other branches; viz. the spring-maker,

* See DOMESTIC SCIENCE page 71.

button-maker, &c. 6. Cap-maker, who employs the springer, &c. 7. Jeweller, which comprises the diamond-cutting, setting, making ruby-holes, &c. 8. Motion-maker, and other branches, viz. slide-maker, edge-maker, and bolt-maker. 9. Spring-maker, (i. e. main-spring) consisting of wire-drawer, &c. hammerer, polisher, and temperer. 10. Chain-maker; this comprises several branches, wire-drawer, link-maker and rivetter, hook-maker, &c. 11. Engraver; who also employs a piercer and name-cutter. 12. Finisher, who employs a wheel and fusee-cutter, and other workers in smaller branches. 13. Gilder is divided into two, viz. gilder and brusher. 14. Glass and hands; the glass employs two, viz. blower and maker: hand-maker employs die-sinker, finisher, &c. 15. Fitter-in, who overlooks the whole, fits hands on, &c. The above fifteen branches are subdivided again and again.

The manufacture of watch-springs also affords an instance of an article raised in price from one halfpenny to the amount of 35,000 guineas. Thus, a pound of crude iron costs one halfpenny; it is converted into steel, that steel into watch-springs, every one of which is sold for half-a-guinea, and weighs only one-tenth of a grain. After deducting for waste, there are, in a pound weight, 7,000 grains; it therefore affords steel for 70,000 watch-springs, the value of which, at half-a-guinea each, is 35,000 guineas.

Why may our cotton manufacture be considered entirely the result of commerce?

Because, had cotton-wool been a native production, we could never have made such astonishing advances in the manufacture had we been denied access to foreign markets. Notwithstanding the splendid discoveries in the machinery, and the perfection to which every department of the trade has been brought, the vast extent of the market has prevented its being glutted; and has stimulated our manufacturers in their

improvements. Our cotton-mills have been constructed, not that they might supply the limited demand of Great Britain, but that they might supply the demand of the whole world. The subdivision of labour, and the scope given to the employment of machinery, by the unlimited extent of the market, has reduced the price of cottons to less, probably, than a fourth part of what it would have been, had they met with no outlet in foreign countries.* The hardware, woollen, leather, and other manufactures, exhibit similar results.

Why is steam said to add to the power of our population?

Because the steam-engines in England represent the power of 320,000 horses, equal to 1,920,000 men; and being in fact managed by only 36,000 men, they consequently add to the power of our population 1,884,000 men.

Steam navigation, a powerful aid to our commercial prosperity, has been thus eloquently illustrated by one of the most accomplished orators of our times. Steamboats—"these new and wonderful machines walk the water, like a giant rejoicing in his course; stemming alike the tempest and the tide; accelerating intercourse; shortening distances; creating, as it were, unexpected neighbourhoods, and new combinations of social and commercial relations; and giving to the fickleness of winds and the faithlessness of waves, the certainty and steadiness of a highway upon the land." —*Canning's Speeches at Liverpool.*

According to M. Dupin, the human force of Great Britain employed in commerce and manufactures, is

* The price of calico 55 years since has been found thus registered in a bible, in the possession of a family near Blackburn:—"15 September, 1776. Thomas Dixbury, of Rishton, near Blackburn, sold to Messrs. Peels, Yates, and Co. Church Bank, two common fine calico pieces for 5*l*. 9*s*. 8*d*. These were the first calico pieces ever manufactured in this kingdom." Pieces of the same description are now sold for 5*s*. 6*d*. or 6*s*. each.—*Mechanics Magazine.*

equivalent to 4,264,000,893 effective men; to this power there must also be added the power of 250,000 animals, employed in divers works of industry. These will raise the animate force of England and Scotland to 6,014,893; to which there must be superadded the approximating value of 1,260,604 effective men for Ireland: so that the commercial and manufacturing animate power of the United Kingdom must be computed at 7,275,497 labouring men. To this must be added the force supplied by water, wind, and steam: thus:—

	Men power.
Animate Force	7,275,497
Mills and Hydraulic Engines	1,200,000
Windmills	240,000
Wind and Navigation	12,000,000
Steam Engines	6,400,000
Total Force	27,115,497
Ireland	1,002,667
Total	28,118,164

In comparison with France, M. Dupin estimates these numbers as follows:—The total of the inanimate force applied to the arts, of all descriptions, in France, scarcely exceeds the fourth of the same power applied to the same purposes in Great Britain; and the whole animate and inanimate power of Great Britain, applied to manufactures and commerce, is nearly triple the amount of that so applied in France.

Why is foreign trade so beneficial to each party engaged in it?

Because each enjoys the peculiar advantages of the respective countries. Thus, when we send cloth or hardware to Portugal for wine, or to Brazil for sugar, we give what is as valuable as that which we receive; and yet both parties gain largely by the transaction; for we get the wine and sugar for what it took to produce them in countries that are peculiarly fitted

for their growth; and the foreigners are supplied with cloth and hardware for what those productions cost in a country where manufacturing industry has been carried to the highest pitch of improvement.

M. Say, in his *Economie Politique Pratique*, thus forcibly illustrates the effects of prohibition in trade. During the reign of Napoleon, vessels were despatched from London, freighted with sugar, coffee, tobacco, cotton-twist, for Salonica, (Macedonia) whence these articles of merchandise were carried by beasts of burden, by the way of Servia and Hungary, to Germany and France; so that an article consumed at Calais, would come from England, only twenty miles distant, by a route which, in point of expense, would be equivalent to a voyage twice round the globe.

Again, the history of our own times affords many striking instances of the prohibitory effects of war upon national industry. In France, the ravages made by the wars of the revolution and of the empire upon her population and wealth, have been estimated, according to M. Dupin, at two millions of men, and 600 millions of English money. Every succeeding year of peace, from 1815 to 1830, has, however, healed these severe wounds; private losses have been indemnified; houses and factories have been rebuilt; the cattle and live stock become more numerous than before the war, and the population increased, in thirteen years, by two millions and a half of inhabitants. As an example of the beneficial effects upon manufacturing industry; it is only since the reestablishment of their intercourse with England, that the French have begun to use pit-coal in their furnaces, and to substitute the instrument called a flattener, or *laminoir*, for the hammer, in beating iron into plates.

Why are certain natural advantages in a country prejudicial to its progress in the arts?

Because, provided the mildness of the climate renders clothing and lodging of little importance, and the

earth spontaneously pours forth an abundant supply of fruits, the inhabitants are immersed in sloth, and seem to place their highest enjoyment in being free from occupation. Sir William Temple, Mr. Hume, and some other sagacious inquirers into the progress of society, have been struck with this circumstance, and have justly remarked that those nations that have laboured under the greatest natural disadvantages, have made the most rapid advances in industry. A striking illustration of the above fact follows.

Why has the improvement of the natives of South America been so tardy?

Because of the extraordinary abundance of animal food, and the equal fertility of the country, where the finest fruits grow spontaneously, and only require to be gathered. Thus, the South Americans are neither a pastoral nor an agricultural people; and, surrounded by partial civilisation, they remain without any excitement to labour, which alone could improve their moral and physical condition. Humboldt has thus beautifully described the state of primitive rudeness in which many of the tribes of South America remain: "When we attentively examine this wild part of America, we appear to be carried back to the first ages, when the earth was peopled step by step; we seem to assist at the birth of human societies. In the Old World we behold the pastoral life prepare a people of huntsmen for the agricultural life. In the New World we look in vain for these progressive developements of civilisation—these moments of repose—these resting-places in the life of a people. The luxury of vegetation embarrasses the Indian in the chase. As the rivers are like arms of the sea, the depth of the water, for many months, prevents their fishing. Those species of ruminating animals, which constitute the riches of the people of the Old World, are wanting in the New. The bison and the musk-ox have not yet been reduced to the domestic state; the enormous multiplication of

the lama and the guanaco have not produced in the natives habits of pastoral life."

Why has the coin of a kingdom been compared to the highways through it?

Because neither of them produce any thing; on the contrary, they are both to be kept in repair at a certain expense; but they greatly facilitate the conveyance from one place to another, of whatever the land produces by agriculture, or what active capital produces by manufactures and commerce. Such is the idea of Dr. Adam Smith, who also compares paper-money to a wagon-way through the air.

Why are we indebted to the ignorance and bad government of our ancestors for our present comparative facility of procuring subsistence?

Because, had it been otherwise, the population that would have accumulated since the reign of William the Conqueror, must have overflowed, like the swarming of the northern hives during the fall of the Roman empire. An entertaining writer says: "If all the Turks and Egyptians that are to die next year of the plague, were to be devoured during the present by crocodiles, a certain quantity of food would be gained, and things go on just as before. The Roman empire, and the world generally, would have been equally populous and prosperous, if the Huns and Ostrogoths had eaten each other, instead of strewing their bones and those of their antagonists through the wilds of Dacia and along the banks of the Danube."

Why is it an error to consider Apothecaries' profits uncommonly extravagant?

Because this great apparent profit is frequently no more than the wages of labour. The skill of an apothecary is a much nicer and more delicate matter than that of any artificer whatever; and the trust which is reposed in him, is of much greater importance. He is the physician of the poor in all cases, and of the rich,

where the distress or danger is not very great. His reward, therefore, ought to be suitable to his skill and his trust, and it arises generally from the price at which he sells his drugs. But the whole drugs which the best employed apothecary in a large market-town will sell in a year, may not, perhaps, cost him above thirty or forty pounds. Though he should sell them, therefore, for three or four hundred, or at a thousand per cent. profit, this may frequently be no more than the reasonable wages of his labour, charged, in the only way in which he can charge them, upon the price of his drugs: the greater part of the apparent profit is real wages disguised in the garb of profit.—*Dr. Adam Smith's Wealth of Nations.*

WEIGHTS AND MEASURES.

Why do we use the grain weight?

Because all weights and measures in England were originally derived from a *grain of wheat:* vide statutes 51 Hen. III. 31 Ed. I. 12 Hen. VII. which enacted that 32 of them, well dried and gathered from the middle of the ear, were to make one penny-weight; but it was subsequently thought better to divide the dwt. into twenty-four equal parts, called *grains.* All measures of capacity, both liquid and dry, were at first taken from troy-weight; and laws were passed in the reign of Henry III. enacting that 8lb. troy of wheat taken from the middle of the ear, and well dried, should make one gallon of wine measure. Weights and measures were invented 869, B. C.; fixed to a standard in England, 1257; regulated, 1492; equalized, 1826.

Why has the pendulum been resorted to in regulating modern weights and measures?

Because it has enabled us practically to carry into effect the idea of seeking for a unit of measure in some unchangeable natural object; the great law of the pendulum being, that its oscillations are always performed

in the same time. The standards that have been usually proposed for the above purpose, have been some aliquot part of the quadrant of the meridian, or the length of a pendulum vibrating seconds in some given latitude. The latter has been in so far adopted into the existing system of weights and measures, established by the Act of Parliament of 1824, that the length of the standard yard, as compared with that of a pendulum vibrating seconds in the latitude of London, is determined to be in the proportion of 36 inches to 39 $\frac{1393}{10000}$ inches.

The pendulum, as a time-keeper, has been mentioned in another portion of the present work.*

Why are the foot, yard, &c. used as measures?

Because the earliest standards seem to have been for the most part derived from portions of the human body: as the cubit, or the length of the arm from the elbow to the tip of the middle finger; the foot; the *ulna*, arm, or yard; the span; the digit, or finger; the fathom, or space from the extremity of the one hand to the extremity of the other, when they are both extended in opposite directions; the pace, &c. These were not, however, *fixed* standards, as the size of the different parts of the human body differ in different individuals: hence it became necessary to select some durable article, a metallic rod, for example, of the length of an average foot, cubit, &c. and to make it the standard with which all the other feet, cubits, &c. used in mensuration, should correspond. These standards have been preserved with the greatest care; at Rome they were kept in the temple of Jupiter; and among the Jews, their custody was entrusted to the family of Aaron.

This standard has been maintained without any sensible variation. In 1742, the Royal Society had a yard made, from a very careful comparison of the standard

* See MECHANICS, p. 14-15.

ells or yards of the reigns of Henry VII. and Elizabeth, kept at the Exchequer. In 1758, an exact copy was made of the Royal Society's yard; and this copy having been examined by a Committee of the House of Commons, and reported by them to be equal to the standard yard, it was marked as such: this identical yard is declared, by the Act 5 Geo. IV. cap. 74, to be the standard of lineal measure in Great Britain.

Without entering into standards of an abstract kind, we may here observe, that "a real material measure must be constructed, and exact copies of it taken. The great difficulty is, however, to preserve it unaltered from age to age; for unless we transmit to posterity the units of our measurements, *such as we have ourselves used them*, we, in fact, only half bequeath to them our observations." Mr. J. F. Herschel thinks this point much neglected, and suggests that "accurate and *perfectly* authentic copies of the yard and pound, executed in platinum, and hermetically sealed in glass, should be deposited deep in the interior of the massive stone-work of some great public building, whence they could only be rescued with a degree of difficulty sufficient to preclude their being disturbed, unless on some very high and urgent occasion. The fact should be publicly recorded, and its memory preserved by an inscription. Indeed, how much valuable and useful information of the actual existing state of arts and knowledge at any period might be transmitted to posterity in a distinct form, if, instead of the absurd and useless deposition of a few coins and medals under the foundations of buildings, specimens of ingenious implements, or condensed statements of scientific truths, or processes in arts and manufactures were substituted."

MONEY.

Why is the term standard used?

Because it may designate the purity and weight of coins; that is, the fineness of the metal of which they are made, and the quantity of it contained in them.

Money was coined in the Temple of Juno *Moneta*, whence our English word *money*, and the *monetary* of political economists.

A pound troy, or 12 oz. of the metal of which English silver coins are made, contains 11 oz. 2 dwts. pure silver, and 18 dwts. alloy. This pound is coined into 66 shillings, so that each shilling contains 80.727 grains of fine silver, and 87.27 grains of standard silver; and the *money pound*, consisting of 20 shillings, contains 1614.545 grains standard silver. From 1600 down to 1816, the pound weight of standard silver bullion was coined into 62 shillings.

The fineness of gold is estimated by carat grains equivalent to 2½ dwts. troy; gold, of the highest degree of fineness, or pure, being said to be 24 carats fine. The purity of our present gold coins is 11 parts fine gold, and 1 part alloy. The sovereign, or 20 shilling piece, contains 113.001 grains fine gold, and 123.274 grains standard gold. The pound troy of standard gold is coined into 46 sovereigns and $\frac{89}{120}$ths of a sovereign, or into 46*l.* 14*s.* 6*d.* The mint or standard price of gold, is, therefore, said to be 46*l.* 14*s.* 6*d.* per lb. troy, or 3*l.* 17*s.* 10½*d.* an ounce.

Why has not the standard been preserved inviolate?

Because of the necessities of governments, and the unfounded notion, so generally diffused, that coins derived their value rather from the coinage than from the quantity of metal contained in them. Coins have been less enfeebled in England than in any other country; but even here the quantity of silver in a pound sterling, is less than the *third* part of a pound weight, the quantity it contained in 1300.

Why is money called sterling?

Because in the time of Richard I., money coined in the east part of Germany, came in special request in England, on account of its purity, and was called Easterling Money, as all the inhabitants of those parts

were called Easterlings; and soon after some of these people, skilled in coining, were sent for to London, to bring the coin to perfection, which was soon called *Sterling*, from Easterling.

Money, as a medium of commerce, is first mentioned in Genesis, chap. xxiii., when Abraham purchased a field as a sepulchre for Sarah, in the year of the world, 2139: money was first made at Argos, 894 years B.C.; has increased eighteen times in value from 1290 to 1530; and twelve times in value from 1530 to 1789. Silver has increased thirty times its value since the Norman Conquest: viz. a pound in that age was three times the quantity it is at present, and ten times its value in purchasing any commodity.

Why is money also called coin and cash?

Because coin (*cuna pecunia,*) from the French *coign*, i. e. *angulus*, a corner, whence it is supposed that the most ancient coin was square. *Cash* is from the French term *caisse*, i.e. chest or coffin, for the keeping of money.

The coining-press was introduced into England in 1562; and machinery for coining by Boulton and Watt, at Soho, near Birmingham, about the year 1800. The coining-press of the Royal Mint has already been noticed.*

Why is there alloy in coins?

Because it may save the trouble and expense that would be incurred in refining the metals to their highest degree of purity; and because, when its quantity is small, it renders the coins harder, and less liable to be worn or rubbed.

Why is there a cross and pile side of a coin?

Because Constantine, with religious zeal, put a cross in place of the beast (to be explained); and in the old Gaulish language, a ship was called *pile:* hence also the game of cross and pile, and the word *pilot.*

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* See MECHANICS, p. 27.

Why is not the value of money the same in all countries?

Because the use of coined money does not change the principle on which exchanges were conducted previously to its introduction. The coinage saves the trouble of weighing and assaying gold and silver, but it does nothing more. It declares the weight and purity of metal in a coin; but the *value* of that metal or coin is, in all cases, determined by those principles which determine the value of other things, and would be as little affected by being recoined with a new denomination, as the burden of a ship by a change of name. Money is, indeed, as much a commodity, as bars of iron or copper, sacks of wheat, &c.

Why do we use the term a pound?

Because, originally, the coins of all countries seem to have had the same denomination as the weights commonly used in them, and contained the exact quantity of the precious metals indicated by their names. Thus, the *talent* was a weight used in the earliest period, by the Greeks; the *as*, or *pondo*, by the Romans; the *pound* by the English and Scotch; and the *livre*, by the French: and the coins originally in use in Greece, Italy, and France, bore the same names, and weighed precisely a talent, a pondo, a livre, and a pound.

The metal which our ancestors used as their medium of exchange, they first divided by pounds, which word still remains among us to signify twenty shillings; this being about the just value that so much copper bore in those days. This was called *as* in Latin, which, according to Varro, is derived from *æs*, signifying copper. They used it first in bullion, unmarked—but to save the trouble of weighing this pound, or the lesser parts of it, and to give it a readier currency, they stamped upon one side the figure of a ship, as an emblem of commerce, with the weight and value; and on the reverse, the picture of one of those beasts which are de-

signed by the word *Pecus*, as being the most prized commodities; whence money came to be afterwards called *Pecunia*, in Latin,—and hence the English word pecuniary.

Why is the guinea so called?

Because the gold with which it was first coined in the reign of Charles II. was brought from Guinea. For this reason also, the guinea originally bore the impression of an elephant.

The term *sovereign* is not new in our coinage: in the time of Edward VI. there were both sovereigns, and half-sovereigns, and nobles, as appropriate attendants on the sovereign.

Why is the shilling so called?

Because of its corruption from the word *scylling*, the etymology of which would lead us to suppose it to have been a certain quantity of uncoined silver; for, whether we derive it from *sceylan*, to divide, or *sceale*, a scale, the idea presented to us by either word is the same—that is, so much silver cut off, as in China, and weighing so much.—*Turner's Anglo-Saxons.*

Why were groats first coined?

Because, in the Saxon time, we had no silver money bigger than a penny, nor after the Conquest, till Edward III., who, about the year 1351, coined *grosses*, (groats, or great pieces,) which passed for fourpence; so the matter stood till the reign of Henry VII., who, in 1504, first coined shillings.

Why is the penny so called?

Because of its derivation from the Latin *pecunia*, money. Until the time of Edward I. the penny was struck with a cross, so deeply indented in it, that it might easily be broken, and parted on occasion, into two parts, thence called *half-pennies;* or into four, thence called *four-things*, or *farthings*. But that prince coined it without indenture, in lieu of which he first struck round halfpence and farthings.

Why was the banking system first introduced into England?

Because, in the turbulent times of the Commonwealth, the merchants and tradesmen, who had before trusted their cash to their servants and apprentices, found that no longer safe; neither durst they leave it in the Mint, by reason of the distress of majesty itself, although this was before a public deposit. In the year 1645, they first placed their cash in the hands of goldsmiths, who began to exercise both professions. We quote these facts from Pennant, who states the first regular banker to have been Mr. Francis Child, goldsmith, who began business soon after the restoration; but Granger mentions Mr. Child as successor to the shop of Alderman Backwel, a banker, in the time of Charles II., who was ruined by the shutting up of the Exchequer, in 1672: he lived in Fleet-street, near Temple Bar, where the banking business of the Childs is conducted to this day.

About fifty years after the above, in 1720, the credit of Bankers was much injured by what has been in our times called a panic, or run. Swift turned their tribulation to humorous account. Thus, in some lines of the above date:—

> "The multitude's capricious pranks
> Are said to represent the seas;
> Which breaking Bankers and the Banks,
> Remove their own where'er they please.
> * * * * * *
> No money left for squand'ring heirs!
> Bills turn the lenders into debtors:
> The wish of Nero now is theirs,
> That they had never known their letters."

Rymer mentions the draft and cheque. The money changers of Scripture, the Trapizæta of the Greeks, and the Argentarii, or Nummularii of the Romans, all illustrate the high antiquity of banking.

Why is the Bank of England an important adjunct of the Government of Great Britain?

Because it receives the taxes, pays the taxes, pays

the interest of the public debt, and conducts the various other pecuniary transactions of the exchequer. For these services the bank receives a per centage, or commission, which amounts annually to about 260,000*l.* to which must be added the profit derived from the use of a floating balance due to the public, never less in amount than four millions sterling. This balance, employed in discounting mercantile bills at the rate of four per cent. yields a revenue of 160,000*l.* per annum, which being added to the commission of 260,000*l.* gives a total of 420,000*l.* as the profit which the proprietors of bank stock derive every year from the connexion subsisting between that establishment and the Treasury.—*Quarterly Review, No.* 86.

The Bank of England was first established in 1694: its projector was one Paterson, born in Dumfrieshire, and said to have died of grief, occasioned by the ingratitude with which he was treated by the world.

Why were the labours of the alchemists beneficial to mankind?

Because, however great their follies, their researches were instrumental in promoting the progress of chemical discovery. Hence, in particular, *metallic pharmacy* derived its origin. Mr. Herschel justly observes, "among the alchemists were men of superior minds, who reasoned while they worked, and who, not content to grope always in the dark, and blunder on their object, sought carefully in the observed nature of their agents for guides in their pursuits."

Why is mercury used in amalgams?

Because, being habitually fluid, it readily combines with most of the metals. When these metallic mixtures contain a sufficient quantity of mercury to render them soft at a mean temperature, they are called *amalgams.*

A work on metallurgy, and the use of quicksilver in refining gold and silver, was written by Alonzo Barba,

a clergyman of the church of St. Bernard, at Potosí, in the year 1640, who has by some writers been supposed to be the inventor of amalgamation. He discovered the process by mere accident; for, being desirous of fixing quicksilver, he mixed it with fine powdered silver ore, and soon found that the mercury had attracted every particle of silver to itself, which presented him with the idea of refining metals by means of quicksilver. This experiment he made in the year 1609, but he was probably unacquainted at that time with smelting works in America, and does not appear desirous of claiming the invention of amalgamation as practised in that country. The book, though published at that late period of the art, and notwithstanding there were many superior treatises on the same subject already published in German, was considered of such importance by the Spaniards, as containing all their metallurgic secrets, that they endeavoured to suppress it: but a portion of it was translated into English in 1674.

WORKING METALS.

Why are the ancient Britons concluded to have been expert in working metals?

Because the art of working in iron and steel had risen to such perfection in the tenth century, that even the horses of some of the chief knights and barons were covered with steel and iron armour. Artificers who wrought in iron were so highly regarded in that warlike time, that every military officer had his smith, who constantly attended his person to keep his arms and armour in order. The chief smith was an officer of considerable dignity in the court of the Anglo-Saxon and Welsh kings, where he enjoyed many privileges, and his wages were much higher than those of any other artificer. In the Welsh court, the king's smith was next in rank to the domestic chaplain, and

was entitled to a draught of every kind of liquor that was brought into the hall.

Why were bellows first invented?

Because they might imitate the action of the lungs and a hollow reed placed in the mouth of the blower, the latter being the first instrument employed for blowing a fire. Our common bellows appear to have been known to the ancient Greeks, and Roman lamps have been found in the form of bellows.

Why is it to be regretted that we know but little of the ancient construction of bellows?

Because more information on this subject would enlarge the knowledge we possess of the metallurgy of the ancients.

Strabo tells us, on the authority of an old historian, that Anacharsis the Scythian philosopher, invented the bellows, the anchor, and the potter's wheel; but this seems doubtful, as Pliny, Seneca, Diogenes, Laertius, and Suidas, only attribute the two last to him; and Strabo also remarks, that the potter's wheel is mentioned by Homer, who lived prior to the time of Anacharsis. It is, therefore, probable that the latter became acquainted with the invention on his travels, and having made it known to his countrymen, was looked upon as the inventor.—*Beckmann.*

Why are forge-bellows constructed with three boards?

Because they are required to keep up a constant and unremitting stream of air through the fuel, to keep it in vivid combustion. Thus, the centre board is fixed, and furnished with a valve opening upwards, the lower board being movable with a valve also opening upwards, and the upper board being under a continual pressure by weights acting upon it. When the lower board is let down, so that the chamber between it and the middle board is enlarged, the air included between these boards being rarefied, the external pressure in the atmosphere will open the valve in the lower board,

and the chamber between the lower and the middle boards will be filled with air in its common state. The lower board is now raised by the power which works the bellows, and the air between it and the middle board is condensed. It cannot escape through the lower valve, because it opens upwards. It acts therefore, with a pressure proportional to the working power on the valve in the middle board, and it forces open this valve, which opens upwards. The air is thus driven from between the lower and middle boards into the chamber between the middle and upper boards. It cannot return from this chamber, because the valve in the middle board opens upwards. The upper board being loaded with weights, it will be condensed while included in this chamber, and will issue from the nozzle with a force proportionate to the weights. While the air is thus rushing from the nozzle, the lower board is let down and again drawn up, and a fresh supply of air is brought into the chamber between the upper and middle board. This air is introduced between the middle and upper board before the former supply has been exhausted, and by working the bellows, with sufficient speed, a large quantity of air will be collected in the upper chamber, so that the weights on the upper board will force a continual stream of air through the nozzle.—*Lardner.*

There are usually two blast-holes to conduct the stream of air from the bellows to the laboratory of the furnace, placed on opposite sides, but so angled that the streams do not impinge on each other. The bellows are commonly cylindrical, and their pistons are worked by a steam-engine.

Why are these bellows superior to the house-bellows?

Because the latter are constructed only with two boards, and have thus only an intermitting action, or blow by fits, the action being suspended while the upper board is being raised.

Why are German bellows made of wood superior to those in common use?

Because the effect produced by them is stronger and more uniform, and they last longer. Some idea may be formed of this contrivance from the following sketch. The entire machine is composed of two boxes placed over each other, the uppermost of which can be moved up and down, in the manner of a lid with a hinge; but the sides of the upper box are sufficiently large to contain the lower between them, when raised to its greatest extent. Both are fastened together at the smallest extremity, where the pipe is inserted by a strong-iron bolt. Thus, when the boxes fit each other with exactness, and the upper is raised over the under, which is immovable, the space contained within both will be increased: consequently, more air will rush in through the valve in the bottom of the lower one; and when the upper box is again pressed down, this air will be expelled forcibly through the pipe. The only difficulty is to prevent any portion of the air from escaping at any other part of the machine than the orifice of the pipe; and this is obviated by the simple contrivance of placing movable slips of wood at the inner sides of the uppermost box, which, by means of metal springs are pressed to the sides of the lower box, and fill up the intervening space. —*Beckmann.*

IRON.

Why is the use of iron believed to have been known in the earliest ages?

Because of its frequent mention in the bible: thus, Tubal Cain, who lived nearly 4,000 years before the commencement of the Christian era, was "an instructer of every artificer in brass and iron." (Gen. iv. 22.) and we read that Abraham took a knife to slay his son Isaac. (Gen. xxii. 10.) In these early times too, mention is made of shears and of shearing of sheep. (Gen. xxxviii. 12, 13.)

Why is this knowledge supposed to have been afterwards lost?

Because many of the ancient nations used stones, flints, the horns and bones of various animals, the bones and shells of fish, reeds and thorns, for every purpose in which the moderns now use edge tools of iron and steel.

Chronology informs us, iron was first discovered by the burning of Mount Ida, 1406 B. C. In England by the Romans, soon after the landing of Cæsar: first discovered in America, in Virginia, 1715: first cast in England, at Blackstead, Sussex, 1544.

Why was iron, at one period forbidden to be used by the Romans, except in agriculture?

Because they thought iron poisonous, and that wounds made with iron instruments healed with difficulty. Chemistry has, however, exposed this fallacy. Fourcroy says iron is the only metal which is not noxious, and whose effects are not to be feared. Indeed, its effects on the animal economy are evidently beneficial.

Why is iron the most useful of metals?

Because it becomes softer by heat, and has the capability of being welded to another piece of iron, so as to form one entire mass: and this may be done without rivets, solder, or melting either of the pieces. No other metal possesses this singular property, except platinum.

An iron wire only one-tenth of an inch in diameter, will carry 450 pounds without breaking. A wire of tempered steel of the same size will carry nearly 900 pounds.—*Black.*

Why has the iron trade of Great Britain increased so extraordinarily since the year 1750?

Because then pit-coal began to be generally used for extracting cast iron from its ores. In 1740, England and Scotland did not possess more than 59 furnaces, producing 17,000 tons; whereas in 1827, they had increased to 284 furnaces, producing 690,000 tons. A

writer in a French Journal, therefore, describes pit-coal as "the prime element of the manufactures and the wealth of England." The mean annual amount of the exportation of iron and steel from this country, in bars and wrought works, is from 1,200,000*l.* to 1,500,000*l.* The annual quantity of iron manufactured in Great Britain is 690,000 tons.

In the great iron works, the ore, broken into small pieces, and mixed with lime or some other substance to promote its fusion, is thrown into the furnace; and baskets of charcoal or coke, in due proportion, are thrown in along with it. A part of the bottom of the furnace is filled with fuel only. This being kindled, the blast of the great bellows is directed on it, and soon raises the whole to a most intense heat: this melts the ore immediately above it, and the reduced metal drops down through the fuel and collects at the bottom. The rest sinks down to fill up the void left by the consumed fuel, and this, in its turn, comes next in the way of the bellows, and is also reduced. More ore and fuel are supplied above, and the operation goes on till the melted metal at the bottom, increasing in quantity, rises almost to the aperture of the blast; it is let out by piercing a hole in the side of the furnace, and then forms what are called *pigs* of cast iron.—*Parkes.*

The Butterley iron-works are amongst the most important in this country. Here are three furnaces, each capable of producing thirty-five tons of pig iron, or crude cast iron, per week. The blast furnaces are about forty feet high, and about thirteen in the largest diameter. When charged, they contain about 3,500 cubic feet of iron stone, coke, and lime-stone, which produce one ton of melting iron. When heated, they are kept in a state of intense heat for many months or years, without intermission, and are constantly supplied at the tops with materials. Blast cylinders, worked by a steam-engine of 80-horse power, continu-

ally urge a stream of air into the furnace. The volume of air thus supporting the combustion, may be estimated by the contents of these cylinders, which are six feet diameter, with a stroke of eight feet long, repeated thirteen times per minute, and doubled by a reciprocity motion, causing a consumption or decomposition of 6240 cubic feet of air per minute. In the foundery attached to these works, were cast the iron-work of Vauxhall Bridge; the columns of the King's Theatre in the Haymarket; many of the works in the dock-yard at Sheerness; the famous roof of the Rum Quay at the West India docks; and nearly all the pipes of the West Middlesex water-works. Sugar-mills for expressing the juice from the cane in the Colonies, are also manufactured here; and the proprietors have exported upwards of 150 steam-engines to the same quarter within the last seven years. Here was made the steam-engine which supplies Calcutta with water: the nabob or king of Oude, has had one to work a pleasure steam-yacht, and another on a small scale to work *punkas* or large fans, to ventilate and cool his apartments.

At the Cognor Park works, on the borders of Derby and Notts. the Butterley Company manufacture bar iron in all its forms of convenience and utility. Their vastness is thus described: " Conceive a space as large as Lincoln's Inn Fields, covered with extended fires and smoke, with the rumbling of blasting engines, the thumping of welding-hammers, and scores of men carrying about masses of iron at a white heat: imagine furnaces of melted iron, with their narrow doors, through which light flows with sensible momentum, and blinds those who dare to look upon the liquid lakes within: behold sets of revolving wheels, one of them twenty-four feet in diameter, weighing twenty tons, yet whirling seventy-two times in a minute; and see the connexion of this balance and regulator: view twenty kinds of apparatus, alive, as it were, and with Cyclops

moving among them, and you have before you these vast Derbyshire iron-works. To comprehend, in a sentence, the works carrying on by the Butterley Company only, I may observe, that in its iron and coal-works it employs twenty-five steam-engines with the power of 700 horses, and at this time gives employment to 1500 men, as miners, colliers, furnace-men, moulders, steam-engine fitters, smiths, labourers, &c."*

Why is Swedish superior to British iron?

Because the Swedes smelt with wood instead of coke. It is imported into England in great quantities, and is chiefly used for carbonization in steel.

Why is iron deprived of its malleability by long-continued hammering?

Because it loses a portion of its latent caloric; Dr. Black being of opinion that metals are malleable in proportion to the matter of heat which they contain in a latent state.

Why is cast-iron puddled and rolled?

Because a principal part of the foreign substances are thus burned away or squeezed out, and malleability is conferred upon the metal by rendering it more pure.

By this curious process of *puddling*, cast-iron, after it has been to a certain extent *refined*, by refusion in a forge, is, in this country, converted into wrought iron. The cast iron is put into a reverberatory furnace, and when in fusion, is stirred, so that every part may be exposed to the air and flames. After a time, the mass heaves, emits a blue flame, gradually grows tough, and becomes less fusible, and at length pulverulent; the fire is then urged, so that the particles again agglutinate at a welding heat, and are gradually wrought up into masses. In that state of intense heat, the masses are passed successively between rollers, and the bars made malleable. They are cut into pieces, placed in parcels in a very hot reverberatory, and again ham-

* Abridged from Sir R. Phillips's *Personal Tour*, Part ii. 1830.

mered or rolled out into bars. They are thus rendered more tough, flexible, and malleable, but much less fusible, and may be considered as nearly pure iron.

Why is iron better cast perpendicularly than horizontally?

Because of the pressure of the upright column, which renders the iron much less liable to air-bubbles and imperfections of that kind, which defeat the skill and calculations of the machinist. If this upright pressure be increased by a weight of extraneous metal, the casting is still more likely to be sound.

Why does a rod of wrought iron, if plunged into cast iron in fusion, become steel?

Because the iron absorbs part of the carbon. What is called *case-hardening*, is a conversion of the *surface* of iron into steel.

Why is the process by which iron is converted into steel, called cementation?

Because it consists in heating bars of the purest iron in contact with charcoal; it absorbs carbon, and increases in weight, at the same time acquiring a blistered surface. This, when drawn down into smaller bars, and beaten, forms *tilted steel;* and this broken up, heated, welded, and again drawn out into bars, forms *shear-steel.*

In this process it has been commonly considered that the carbon combines *mechanically* with the iron; our chemists have, however, long been of opinion, that it is a *chemical* combination that takes place, by the gradual absorption of carbon in the gaseous state, by the iron. This fact has been proved by Mr. Charles Mackintosh, of Crossbasket, Lanark, who has taken out a patent for preparing steel, by subjecting the iron to a stream of carburetted hydrogen gas, evolved from coal under distillation. This iron is enclosed in a pot or crucible in the furnace, and when arrived at the proper heat, a stream of gas is directed by a pipe into the

crucible, which has another aperture to allow that part of the gas to escape, which has not been taken up by the metal. Steel, in ingots, is porous; but, to confer solidity, it is hammered, tilted, and rolled. At Attercliffe, near Sheffield, are extensive works for these purposes. Here, by the power of a water-wheel, fifteen feet in diameter, hammers are worked, weighing from 3 to 4½ cwt. and strike, at ten or twelve inches fall, from 100 to 220 times in a minute. The ingots, at a strong red heat, are exposed to the action of these hammers, and the metals condensed into bars, which are next submitted, at the same degree of heat, to the tilting hammer, which gives 300 strokes per minute: lastly, they are rolled or flattened into sheets, and drawn into lengths. Six tons a week are hammered down by one hammer; about three tons are tilted; and twenty-four tons can be rolled, working night and day, by relays of hands.

The making of steel is a British manufacture scarcely sixty years old. Previously it came from Austria and Syria, and was dear and little used. It is, however, now heated, welded, cut, and moulded in this country, with nearly the same facility as deal wood by an ordinary carpenter.

Why does a drop of nitric acid, let fall upon steel, occasion a black spot?

Because the iron is dissolved, and the carbon thereby exposed to view.—*Parkes.*

Why is steel tempered?

Because, when steel is heated to a cherry-red colour, and then plunged into cold water, it becomes so extremely hard and brittle, as to be unfit for almost any practical purpose; and *tempering* reduces it from this extreme hardness, by heating it to a certain point or temperature.

The polishing of steel is not executed in the same manner as that of the softer metals: the steel is not

polished until it has been hardened, and the harder it is, the more brilliant will be its polish. Rotten-stone, a kind of very light tripoli, but finer than the other sorts, and found near Bakewell, in Derbyshire, is esteemed for general polishing; but steel, from its extreme hardness, requires to be polished with emery.

Why are various colours produced on heated steel?

Because of the oxidation which takes place, as is proved from the circumstance that when steel is heated and suffered to cool under mercury or oil, none of the colours appear; nor do they when it is heated in hydrogen or nitrogen.—*Brande.*

Why is it customary to judge of the temper of steel by its colours?

Because, the surface being a little brightened, exhibits, when heated, various colours, which constantly change as the temperature increases. Thus, when steel is placed in a bath heated to 600°, the first change is at about 430°, which is very faint; at 460°, the colour is straw, becoming deeper as the temperature is increased; at 500°, the colour is brown; this is followed by a red tinge, with streaks of purple, then purple; and at nearly 600°, it is blue. The degrees at which the different colours are produced, being thus known, the workman has only to heat the bath with its contents up to the required point. For example, suppose the blade of a pen-knife, (or a hundred of them,) to require tempering; they are suffered to remain in the bath until the mercury in the thermometer rises to 460°, and no longer, that being the heat at which the knife (supposing it to be made of the best English cast steel) will be sufficiently tempered.

Why is cast steel so called?

Because it is prepared by fusing blistered steel with a flux composed of carbonaceous and vitrifiable ingredients, casting it into ingots, and afterwards by gentle heating, and careful hammering, giving it the form of bars.

Why is the Peruvian steel so called?

Because it is an alloy of steel with certain portions of other metals from Peru. It is, technically speaking, *sadder*, not so easy to work as other steel, and yet much harder and tougher than any other.

CUTLERY.

Why is steel used for making cutting instruments?

Because it combines the fusibility of cast with the malleability of bar iron, and when heated and suddenly cooled, becomes very hard.

The rapidity with which razors, knives, &c. are produced from the raw material, is truly astonishing. Thus in the workshops at Sheffield, we may in a few minutes see dinner knives made from the steel bar and all the process of hammering it into form, welding the tang of the handle to the steel of the blade, hardening the metal by cooling it in water and tempering it by de-carbonizing it in the fire.

The number of hands through which a common table-knife passes in its formation is worthy of being known to all who use them. The bar steel is heated in the forge by *the maker*, and he and *the striker* reduce it in a few minutes into the shape of a knife. He then heats a bar of iron and welds it to the steel so as to form the tang of the blade which goes into the handle. All this is done with the simplest tools and contrivances. A few strokes of the hammer in connexion with some trifling moulds and measures, attached to the anvil, perfect, in two or three minutes the blade and its tang or shank. Two men, the maker, and striker, produce about nine blades in an hour, or seven dozen and a half per day. The rough blade thus produced, then passes through the hands of the filer, who files the blade into form by means of a pattern in hard steel. It then goes to the hafters to be hafted in ivory, horn, &c. and then to the finisher. In this profession, every table-knife, pocket-knife, or pen-knife, passes, step by step, through no less than 16 hands or 144 separate stages of workmanship.

Sheffield employed about 15,000 persons in these departments, four years since:

On table-knives	- - - - - - -	2,240
On spring-knives	- - - - - -	2,190
On razors	- - - - - - -	478
On scissors	- - - - - - -	806
On files	- - - - - - - -	1,284
On saws	- - - - - - - -	400
On edged tools	- - - - - - -	541
On forks	- - - - - - - -	480
In the country	- - - - - -	130
In the plated trade nearly	- - - -	2000
	About	10,549

Besides those who are employed in Britannia-metal ware, smelting, optical instruments, grinding, polishing, &c. &c. making full 5,000 more. There are full 1,700 forges engaged in the various branches of the trades, and of course as many fires.

Why are the most minute instruments generally made with good steel?

Because it is much more ductile than iron: a finer wire being drawn from it than from any other metal.

Why is Wootz or Indian steel the most valuable for making edge tools?

Because it is combined with a minute portion of the earths, alumina and silica; or rather perhaps, with the bases of these earths. Whether the earths are found in the oar, or are furnished by the crucible in making the steel, is not certainly known; nor is the Indian steel-maker probably aware of their presence. Wootz, in the state in which it is imported, is not fit to make into fine cutlery. It requires a second fusion, by which the whole mass is purified and equalized, and fitted for forming the finest edge instruments.—*Brande.*

Why does a razor operate best when dipped in hot water?

Because the temperature of the blade has then been

raised, and the fineness of the edge proportionally increased.

In some experiments, the knife edges attached to the pendulum described by Captain Kater, in *Phil. Trans.* 1818, on being carefully hardened and tempered in the bath at 432°, were, on trial, found too soft. They were a second time hardened, and then heated to 212°, at which point the edges were admirably tempered. This, it will be remembered, is the heat of boiling water, and further illustrates the preceding question.

In the manufacture of a razor, it proceeds through a dozen hands; but it is afterwards submitted to a process of grinding, by which the concavity is perfected, and the fine edge produced. They are made from 1*s*. per dozen, to 20*s*. per razor, in which last the handle is valued at 16*s*. 6*d*.—Scissors, in like manner, are made by hand, and every pair passes through sixteen or seventeen hands, including fifty or sixty operations, before they are ready for sale. Common scissors are cast, and when riveted, are sold as low as 4*s*. 6*d*. per gross! Small pocket knives too are cast, both in blades and handles, and sold at 6*s*. per gross, or a halfpenny each! These low articles are exported in vast quantities in casks to all parts of the world.

ZINC.

Why is Zinc useful in the arts?

Because, in combination with copper or tin, in various proportions, it forms some of the most useful compound metals or alloys. Thus, with copper, it constitutes brass, pinchback, and tombac; with little copper, Prince's metal;* with tin and copper, bronze.

Roofs covered with zinc are very numerous in the Low Countries but have one bad quality. In cases of fire, the zinc being very combustible, soon becomes inflamed, and falling all around, occasions great danger

*See DOMESTIC SCIENCE, page 65.

to those who approach the building. In short, zinc is the most combustible metal we have. If beaten out into thin leaves, it will take fire from the flame of a common taper.

Why has the oxide of zinc been substituted for white lead in house-painting.

Because it preserves a good colour much longer: it is not, however, of so perfect a white as lead.

TIN.

Why did the ancients mix tin with their copper coins and edge tools?

Because it occasioned the coins to wear longer, and it imparted sufficient hardness to the copper to render it capable of forming very good cutting instruments. Mr. Parkes, in analysing several Roman brass coins, from various periods of the Empire, found tin to be a component part in all of them.

Why is not Spanish tin used in this country?

Because it bears a prohibitory duty of 30*l.* per cent. It is raised in great quantities in South America, and is very pure, but not so neatly manufactured as the Cornish tin. According to Aristotle, the tin mines of Cornwall were known and worked in his time. Diodorus Siculus, who wrote 40 years before Christ, describes the method of working these mines, and says, that their produce was conveyed to Gaul, and thence to different parts of Italy. The miners of Cornwall were so celebrated for their knowledge of working metals, that about the middle of the 17th century, the renowned Becher, a Physician of Spire, and tutor of Stahl, came over to this country to visit them.

A celebrated tin mine was the famous *wherry mine*, near Penzance. The shaft through which the miners went down to work, was situated nearly 100 yards below water mark. "The opening of this mine" says Dr. Maton, "was an astonishingly adventurous undertaking. Imagine the descent into a mine through the sea, the miners working at the depth of 17 fathoms

below the waves; the rod of a steam engine, extending from the shore to the shaft, a distance of nearly 120 fathoms, and a great number of men momentarily menaced with an inundation of the sea, which continually drains in no small quantity through the roof of the mine, and roars loud enough to be distinctly heard in it." The working of this mine was wholly given up in the year 1798.

Such is the mineral wealth of Cornwall, that it contains more men, who possess fortunes, sprung from the mines, of five and from that to twenty thousand pounds, than there are in any other county of England, excepting the metropolis and its vicinity; and there are some instances of individuals acquiring from fifty to two hundred thousand pounds, from the mines, and by a fortunate course of trade.

Why should tin be chosen for its lightness?

Because its purity is in exact ratio with its levity; while gold, on the contrary, unless alloyed with platinum, is fine in proportion to its density.

Why is tin so important to the dyer?

Because it is employed to give a brightness to cochineal,* archil, and other articles used in forming reds and scarlets; and to precipitate the colouring matter of other dyes. For these purposes it is previously dissolved in a peculiar kind of *aqua-fortis*, called *dyers' spirit.*

Tin is consumed in large quantities by the dyers; it is also used for covering sheet iron to prevent its rusting, and in forming plumbers' solder, speculum metal, pewter, and some other alloys. Its oxides are used in polishing glass, in glazing some kinds of earthenware, &c.

Why is tin-plate so called?

Because it is made by dipping clean iron plates into melted tin. When tin-plate is washed over with

* See ZOOLOGY—*Insects*, page 258.

a weak acid, the crystalline texture of the tin becomes beautifully evident, forming an appearance which has been called *moire metallique.*

Why are pins whitened by boiling in grain-tin and supertartrate of potash?

Because the tartaric acid first dissolves the tin, and then gradually deposits it on the surface of the pins, in consequence of its greater affinity for the zinc, of which the brass wire is composed.

Why were the Stannary Courts so called?

Because they regulated the affairs of the tin (*Stannum*, Latin,) mines, and determined causes among the tinners, whether criminal or actions for debt. At Lydford, on the borders of Dartmoor, was one of the Stannary prisons: hence the Devon and Cornwall saying:

> "First hang and draw,
> Then hear the cause by Lydford Law;"

or Lydford Law, by which they hang men first, and try them afterwards.

LEAD.

Why is lead employed in refining the precious metals?

Because when mixed with them in a great heat, it rises to the surface combined with all heterogeneous matter. Lead is employed to cover buildings, to form water-pipes, (though Vitruvius, the Roman architect, in the time of Augustus, condemned this practice,) and to make a great variety of vessels for economical purposes. Its oxides are used for dyeing and calico-printing, in the manufacture of glass, earthenware, and porcelain: and lead is capable of forming various alloys. There is also a large consumption of lead in making shot.*

Why is lead employed in the manufacture of white metal buttons?

Because it has been discovered that a certain pro-

* See MECHANICS, p. 90.

portion of lead may be mixed with the metal formerly used, without injuring the appearance of the button; thus affording a very considerable additional profit to the manufacturer.

Why is lead employed to correct harsh wine?

Because it has the property of imparting a saccharine taste when dissolved in acids, as in that of the wine. The ancients knew that this metal rendered harsh wine milder, but it was not universally known to be poisonous. According to Pliny, the Greeks and Romans proved the quality of their wines by dipping a plate of lead in them. Lead will also take off the rancidity of oils.

Why were blocks of lead called pigs?

Because they might be distinguished from larger blocks, called *sows*, which latter term is still retained in the word *sow-metal.* In 1773, a pig of lead was dug up near Tamworth, with an inscription of the date 76, A.D., or 1697 years old; thus proving lead to have been used by the Romans in this country.

Why is lead cast in such regular sheets?

Because the melted metal is suffered to run out of a box through a long horizontal slit upon a table prepared for the purpose, while the box is drawn by appropriate ropes and pulleys along the table, leaving the melted lead behind it in the desired form, to congeal. The lead thus cast is then passed between two iron rollers placed at such a distance from each other, as will reduce it to the requisite thickness.

Why is common lead changed into red lead by melting it in ovens with a free access of atmospheric air?

Because the lead absorbs so much oxygen as to become converted into an oxide. Thus, the melted lead is exposed until the surface is covered with a pellicle; this pellicle being removed, another is formed; and thus, by successively removing the pellicle as it forms, the greater part of the lead is soon changed into a yel-

lowish-green powder. This powder is then ground in a mill, and when it has been washed and properly dried, is thrown back into the furnace; and this, by constant stirring for thirty or forty hours, so as to expose every part to the action of the air, becomes red lead, and is taken out for use. Twenty cwt. of lead generally give 22 cwt. of red lead; so that 2 cwt. of oxygen are absorbed from the atmosphere during the process.

The only important alloys of lead are those with tin. Common *pewter* consists of about 80 parts of tin and 20 of lead. Equal parts of lead and tin constitute *plumbers' solder*; and what is termed *pot-metal*, is an alloy of lead and copper.

The reduction of native lead upon a large scale, is a sufficiently simple process. The picked ore, after having been broken and washed, is roasted in a reverberatory fire, the temperature being such as to soften but not fuse it. During this operation, it is raked till the fumes of sulphur are dissipated, when it is brought into perfect fusion; the lead, reduced by the fuel, sinks to the bottom, and runs out into oblong moulds called *pigs*; the scoriæ are again melted, and furnish a portion of less pure metal. The mines of Great Britain afford an annual produce of about 48,000 tons of smelted lead. There is a peculiar variety of native lead, called in Derbyshire *Slickensides*, which, when touched by the miners' pick, often splits asunder with a kind of explosion.*

Plumbago, graphite, or *black-lead*, is generally regarded as a true carburet of iron: it is not uncommon, though rarely found sufficiently pure for pencils; the coarser kinds, and the dust, are melted with sulphur,

* The practice and laws of mining in Derbyshire, are somewhat curious. Sir Richard Phillips, in his recent *Personal Tour*, tells us, "there is a large district called *the King's Field*, and as the king is entitled to a share, so any person finding a vein of ore, may, on giving notice to the *Bar-master*, an officer so called, work the said vein for his own benefit, and the king's. The Bar-master then places a cross-stick on the spot, and the vein is deemed the legal property of the discoverer, who is, moreover, entitled to a right of way to the nearest public road."

for common carpenters' pencils: it is sometimes used in manufacturing crucibles, and in compositions for covering cast-iron, and for diminishing friction in machinery.*

Mr. Bakewell was informed at the celebrated mine in Borrowdale, that black-lead, to the amount of one thousand pounds, had been obtained there in one day.

Why is common white-lead made by exposing sheet-lead to acetic acid?

Because the fumes of the acid oxidize the metal Thus, a number of crucibles, holding from three to six quarts each, and nearly filled with vinegar, are placed in hot-beds of tan: upon these crucibles thin sheets of lead, rolled up in coils, are placed, one coil over each crucible. The heat of the bed occasions the vinegar to rise in vapours, and this attaches itself to the lead, and oxidizes its surface to a considerable depth. The oxide which has been thus formed, is scraped off, and the coils of lead replaced: in this manner the operation is repeated, until the whole of the metal is oxidized. This oxide, which contains a portion of carbonic acid, is afterwards washed, and ground for sale.

Why does linseed-oil, boiled with red-lead, become drying oil?

Because the oxygen of the metal combines with the oil, imparting to it the property of drying quickly.

ANTIMONY.

Why is antimony important in the arts?

Because, alloyed with lead, in the proportion of 1 to 16, and a small addition of copper, it forms the alloy used for printers' types: with lead only, a white and rather brittle compound is formed, used for the plates upon which music is engraved. With tin, antimony constitutes a kind of pewter, a term, however, applied to an alloy of lead and tin. The finest pewter consists

* See MECHANICS, page 36.

of about twelve parts of tin and one of antimony, with a small addition of copper. A good white metal, (Britannia) used for tea-pots, is composed of 100 tin, 8 antimony, 2 bismuth, and 2 copper.

COPPER.

Why is copper chosen for making trumpets and other musical instruments?

Because of its sonorous property.

Why is copper-wire chosen by wire-dancers?

Because of its great elasticity. Thus a wire 1-10th of an inch in diameter, will support nearly 300 lb.

The first copper smelting works were established at Swansea, about a century ago,—but the business has so increased, that it is calculated not fewer than 10,000 persons are now employed in the works and the collieries, and the shipping connected with them.

The following is an outline of the process by which ores of copper are reduced, as carried on upon a large scale near Swansea, where the chief part of the Cornish ores are brought to the state of metal. The ore, having been picked and broken, is heated in a reverberatory furnace, by which arsenic and sulphur are driven off. It is then transferred to a smaller reverberatory, where it is fused, and the slag which separates, being occasionally removed, is cast into oblong masses, used as a substitute for bricks. The impure metal collected at the bottom of the furnace, is granulated by letting it run into water; it is afterwards melted and granulated two or three times successively, in order further to separate impurities, which are chiefly sulphur, iron, and arsenic, and ultimately cast into oblong pieces called pigs, which are broken up, roasted, and lastly melted with charcoal in the refining furnace. Malleability is here conferred upon the copper, and its texture improved by stirring the metal with a pole of green wood, generally birch, which causes great ebullition and agitation; assays are occasionally taken out, and

the metal, originally crystalline and granular when cold, now becomes fine and close, so as to assume a silky polish when the assays are half cut through and broken. The metal is now cast into cakes about twelve inches wide, by eighteen in length. Copper for brass-making is granulated by pouring the metal through a perforated ladle into water; when this is warm, the copper assumes a rounded form, and is called *belan shot;* but if a constant supply of cold water is kept up it becomes ragged, and is called *feathered shot.* Another form into which copper is cast, chiefly for exports to the East Indies, is in pieces of the length of six inches, and weighing about eight ounces each: the copper is dropped from the moulds, immediately on its becoming solid, into a cistern of cold water; and thus, by a slight oxidation of the metal, the sticks acquire a rich red colour on the surface. This is called *Japan Copper.—Brande.*

Sulphate of copper, or Roman vitriol, is much used by dyers, and in many of the arts. Fowling-pieces and tea-urns are browned, by washing them with a solution of this salt. Verdigris is an acetate of copper. Blue verditer, much used in staining paper for hanging rooms, is a nitrate of copper, combined with hydrate of lime. Mineral and Brunswick green, are likewise combinations of copper with potash, &c. At Montpellier, the manufacture of rough verdigris is part of the household business in the wine-farms, and is generally done by the women.

The annual value and produce of the copper and tin from the mines of Cornwall and Devonshire, on an average of several years, may be stated at 75,000 tons of copper ore, value £800,000. sterling; 3,250 tons of metallic tin, value £227,000.—*Bakewell's Geology.*

According to the tables of the produce of the soft metals raised in Great Britain, as given in a work entitled *Records of Mining*, the quantity raised in a year

is as follows:—copper, 16,635 tons; lead, 47,000 tons; and tin, 5,316 tons.

Why is the rust advantageous to copper?

Because the corroded part is very thin, and preserves the metal beneath from further corrosion.

Why have small bells a shrill tone?

Because zinc is added to their composition, usually consisting of three parts copper and one of tin.

Why has apparatus been invented for sounding bells without pulling?

Because buildings suffer much from the sounding of bells, especially when they are very heavy. Let one, in fact, only imagine a mass of several tons swinging to and fro, and he will readily perceive how much a building must be shaken by it. In Denmark, Professor Oersted has introduced into a bell a balance; similar to that of a pendulum. An axis, by turning, raises a hammer, which, at each turn, strikes the bell, and produces a sound which cannot be distinguished from that emitted by the bell when tolled.

The largest bells in the world are to be found in Russia, The "Great Bell" of Moscow, cast in the year 1736, weighs 432,000 pounds, is 19 feet high, 21 yards in circumference at the bottom, and at its greatest thickness 23 inches.*

Why should children be cautioned against eating the imitative gold on gingerbread, &c.?

Because it is nothing more than a fine kind of brass, which is supposed to be made by cementation of copper plates with calamine, and hammered out into leaves

* Mirrors are also cast of larger dimensions at St. Petersburgh, than elsewhere. In the Imperial manufactory here, was cast for Prince Potemkin, a mirror, measuring 194 inches by 100. One, of the same proportions, and valued at three thousands guineas, was cast for the Duke of Wellington, a few years since, but was broken to atoms in its conveyance from St. Petersburgh to England.

in Germany. It is sold very cheap in this country, under the name of Dutch gold or Dutch metal. It is about five times as thick as gold leaf; that is to say, it is about one sixty-thousandth of an inch thick.

Why is tin preferable to other metals for lining copper vessels?

Because it combines with copper at a much lower temperature than is necessary to fuse the copper alone. When vessels are tinned, they are first scraped or scoured; after which they are rubbed with sal-ammoniac. They are then heated, and sprinkled with powdered resin, which defends the clean surface of the copper from acquiring the slight film of oxide, that would prevent the adhesion of the tin to its surface. The melted tin is then poured in and spread about. An extremely small quantity adheres to the copper, which may perhaps be supposed insufficient to prevent the noxious effects of the copper as perfectly as might be wished.

Why do watchmakers prefer Dutch brass to the English?

Because of its superior ductility, which is owing to the large proportion of copper contained in it; the Dutch being a compound of two atoms of copper and one of zinc, while the English is of equal parts of copper and zinc.—*Thomson.*

COBALT.

Why is cobalt extremely valuable to the manufacturers of porcelain?

Because it not only produces a beautiful colour, but endures the extreme heat of their furnaces unaltered. This colour is so intense, that a single grain of the pure oxide will give a deep tint of blue to 240 grains of glass. Smalt, or powder-blue, used by laundresses, consists of oxide of cobalt, ground impalpably with flint-glass. This is also used to give a blue tinge to writing and printing papers.

Cobalt ores generally contain arsenic: they are so contaminated with it, that the workmen who are employed seldom live many years.

Why is cobalt especially valuable in the fine arts?

Because its oxide forms the most permanent blue colour that we are acquainted with. La Grange says that the old painters used this oxide mixed with oil in their paintings, which is the reason why the sky and drapery in some old pictures are of so durable a blue.

BISMUTH.

Why is bismuth important in the composition for printing-types?

Because it has the singular property of expanding as it cools; and from this expansive property are obtained the most perfect impressions of the moulds in which the letters are cast. The larger kind of types are generally made with lead and antimony, in the proportion of from 4 to 16 parts of the former to one of the latter.

SILVER.

Why is silver alloyed with copper for plate and coin?

Because the former metal is thus rendered harder and more sonorous, while its colour is scarcely impaired.

The silver mines of Mexico and Peru far exceed in value the whole of the European and Asiatic mines: for we are told by Humboldt, that three mines, in the space of three centuries, afforded 316,023,883 pounds troy of pure silver; and he remarks that this quantity would form a solid globe of silver, 91,206 English feet in diameter. (*Jameson.*) Mr. Helms is of opinion that the Andes, if properly examined, would afford silver enough to overturn our present commercial system, by making silver as common as copper.

Silver has also been obtained from some of the lead mines of Great Britain. Bishop Watson, in his *Chemical Essays*, notes, "By the silver which was produced

from the lead mines in Cardiganshire, Sir Hugh Middleton is said to have cleared two thousand pounds a month, and that this enabled him to undertake the great work of bringing the new river from Ware to London."

Why does silver tarnish and blacken?

Because of the sulphureous vapours in the atmosphere: pure water has no effect upon silver; but if the water contain vegetable or animal matter, it often slightly blackens its surface in consequence of the presence of sulphur.

Why is the German "silver" improperly so named?

Because it is nothing more than the white copper long known in China, and does not contain a particle of silver; it is only an alloy of copper, metal, and nickel. Although only now coming into known use in England, it has been no stranger to the manufactories of Birmingham for at least twenty years or more.

Why is plating so called?

Because it is performed by the application of a plate of silver to the surface of copper, which is afterwards beaten or drawn out. Amalgam of silver is sometimes employed for plating; it is applied to the surface of the copper, and the mercury being evaporated by heat, the remaining silver is burnished. A mixture of chloride of silver, chalk, and pearlash is employed for silvering brass: the metal is rendered very clear, and the above mixture, moistened with water, rubbed upon its surface. In this way, thermometer scales and clock dials are usually silvered.

A note upon the duty on plate will show how large a portion of gold and silver is annually diverted from the purposes of coin to those of ornament and luxury. The rate of duty upon silver wrought plate in 1804, was 1*s*. 3*d*.; upon gold 16*s*. per ounce; it was afterwards raised to 1*s*. 6*d*. upon silver, and to 17*s*. upon gold. At this time the annual net duty was less than 5000*l*.;

in 1828, it was upwards of 105,000*l.*; a rise more than twenty-fold, notwithstanding the greatly diminished supply from the mines, and the consequent increasing value of the precious metals.

Why is coal gas injurious to silver and plated goods?

Because of the sulphuretted hydrogen which it contains.

Why is the Birmingham and Sheffield plate superior to that formerly made?

Because the old method was by dissolving mercury in nitrous acid, dipping the copper, and depending on the affinity of the metals, by which a very slight article was produced. But at Sheffield and Birmingham, all plate is now produced by rolling ingots of copper and silver together. About the eighth of an inch in thickness of silver is united by heat to an inch of copper in ingots about the size of a brick. It is then flattened by steel rollers worked by an eighty-horse power. The greater malleability of the silver occasions it to spread equally with the copper into a sheet of any required thickness, according to the nature of the article for which it is wanted. Plated metal, the eighth of an inch thick, is thus rolled by the hand into ten times the surface, the silver spreading equally; and the plating would be perfect if the rolling had reduced it to the thinness of silver paper! This mode of plating secures to modern plate a durability not possessed by any plate silvered by immersion. Hence plated goods are now sought all over the world, and, if fairly used, are nearly as durable as silver itself. Of this material, dinner and dessert services have been manufactured at from fifty to three hundred guineas, and breakfast sets from ten to two hundred guineas, as sold on the spot.

GOLD.

Why is gold alloyed with copper for coin?

Because it is thus made harder than pure gold, and

resists wear better than any other alloy except that with silver.

The produce of the Ural gold mines amounted, in 1827, to 672,416*l*. Gold is also found in the Rhine; but the quantity is so scanty, that the washer considers it a good day's work, if he succeed in collecting to the value of 5*s*. or 6*s*. From the official accounts of the yearly produce obtained from that stream in the Grand Duchy of Baden, we observe the value was, in 1821-2, £603; 1826, £808; 1827-8, £943. The last produce, small as it may appear, for it scarcely exceeded 17 pounds in weight, showed so considerable an increase upon preceding years, that a great impulse was given to this branch of industry in Baden.

We have already noticed the malleability of gold, though not its actual limit; * for the gold-beaters find it necessary to add three grains of copper in the ounce, to harden the gold, which otherwise would pass round the irregularities of the newest skins, and not over them: and in using the old skins, which are not so perfect and smooth, they even add twelve grains. The wire which is used by the lace-makers, is drawn from an ingot of silver, previously gilded. In this way, from the known diameter of the wire, or breadth when flattened, and its length, together with the quantity of gold used, it is found, by computation, that the covering of gold is only 1-12th part of the thickness of gold leaf, though it is still so perfect as to exhibit no cracks when viewed through a microscope.

Fifty thousand pounds worth of gold and silver are said to be annually employed at Birmingham in gilding and plating, and of course lost for ever as bullion. —The ductility of gold is such, that one ounce of it is sufficient to gild a silver wire more than 1,300 miles long.

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* See MECHANICS, p. 17.

Why is mercury used to separate gold and silver from the extraneous matter found with those metals?

Because, by triturating the mass with mercury, the gold and silver become amalgamated with it; and afterwards this amalgam is submitted to heat, when the mercury sublimes; the precious metals leaving in a state of purity.

The gilding of buttons is, in part, similarly effected. When the buttons, which are of copper, are made, they are dipped into dilute nitric acid, to clean them, and then burnished with a hard black stone: they are then put into a nitric solution of mercury, and stirred about with a brush till they are quite white: an amalgam of gold and mercury is then put into an earthen vessel with a small quantity of dilute nitric acid; and in this mixture the buttons are stirred till the gold attaches to their surface: they are then heated over the fire till the mercury begins to run, when they are thrown into a large cap made of coarse wool and goat's hair, and in this they are stirred about with a brush. The mercury is then volatilized, by heating over the fire in a pan. By Act of Parliament, a gross of buttons, of an inch diameter, are required to have five grains of gold on them; but many are deficient even of this small quantity.

Why is false gilding so called?

Because it is the art of applying thin leaves of silver, or of tin, to the substance to be gilded, and then rubbing them over with a yellow transparent colour, through which the metallic splendour appears: this is very old; and a method of affixing a white metal to paper, and then covering it with a gold varnish, has been known in China from the earliest ages. It appears also to have been employed at a very remote period for gilding leather, of which many specimens may be found in ancient leathern tapestry.

PLATINUM.

Why is platinum so called?

Because it resembles silver; the term, in the language of Peru, meaning "little silver."

Platinum may always be known from other metals by its superior specific gravity, it being the heaviest body in nature. The important uses to which this precious metal may be applied, can be easily conceived, when it is considered that it unites the indestructibility of gold to a degree of hardness almost equal to that of iron; that it resists the action of the most violent fire, and also of the most concentrated acids. One of its more useful applications has been to the coating of copper with as much ease as the common operation of tinning. The high value of platinum is however very much against its general adoption, for although much cheaper than gold, it is worth between four and five times its weight of silver.

Why is the alloy of steel and platinum well adapted for mirrors?

Because it takes a fine polish and does not tarnish.

Why is platinum well adapted for the manufacture of rings and chains?

Because it has the property of being united by welding, either one piece to another, or with iron, or steel. Hence its durability must add to its value.

A beautiful coinage of platinum has lately been issued in Russia, the metal being found in considerable quantities in the Uralian mountains of Siberia.

Why is rhodium used for the nibs of metallic pens?

Because of its extreme hardness and durability. For this successful application, the elegant arts are indebted to the suggestion of the late Dr. Wollaston.

GLASS.

Why is lead important in glass?

Because its oxide, in the form of litharge, or minium, increases the fusibility of the compound, gives

it greater tenaciousness when hot, increases its refractive power, and enables it to bear sudden changes of temperature. It is a copious ingredient in the *London flint glass*, celebrated for its brilliancy when cut, and used for most optical purposes. Lead, however, renders glass so soft as easily to scratch.

The manufacture of glass is as follows:—The glass-pots are placed round a dome-shaped furnace, built upon arches, and open beneath for the free admission of air; there are generally six in each furnace, and they are entirely enclosed, except at an orifice on the side opening into a small recess formed by the alternate projection of the masonry and the flues, in which the workmen stand. Coal is the fuel employed, and the furnace is so built that a rapid current of flame may be directed round each glass-pot, which afterwards passes out with the smoke into the dome and chimney, heating a broad covered shelf in its passage, which is the annealing oven. The materials, or fret, being fused, and the impurities removed, gradually become clearer, abundance of air-bubbles are extricated, and at length the glass appears uniform and complete; the fire round each individual pot is then damped, till its contents acquire a consistency fit for working; the whole process requiring about forty-eight hours from the time the pots are filled. At the working heat, which is a full red, the glass has a peculiarly tenacious consistency, and as it adheres but feebly to polished metals, it is easily wrought and managed with iron tools.*

*Mr. Brande, in a note to his *Manual of Chemistry*, observes: "All common glass, when reduced to a fine powder, is more or less acted on by boiling water, which separates the alkali, and its entire disintegration seems only to be prevented by the insolubility of the silica. Glass which has long been exposed to the weather, frequently exhibits a beautiful irridescent appearance, and is so far decayed, that it may be scratched with the nail. Several years ago, I examined some bottles of wine which had lain in a wet cellar, near the Bank, upwards of 150 years, having been deposited there (as circumstances proved) previous to the great fire of London in 1666. The glass was soft, and greatly corroded upon the surface, in consequence of the abstraction of its alkali. The wine appeared to have been Malaga and Claret; the latter had perished, but the former was still vinous."

It is a curious fact in the history of discovery, that the manufacture of glass is unknown at Sidon, though this part of the country was once famous for the discovery of, as well as production of articles in, that material. The story of the discovery of glass by Phœnician mariners at Belus, near Sidon, in Syria, is mentioned by Pliny. Dyeing, however, is still practised, though not with the same success as among the ancient Tyrians, who were descended from the builders of Sidon. The standard of Syria in arts and manufactures, is, indeed, every where, much below that of the most backward nation in Europe.

Why do all glass articles require to be carefully annealed, or suffered to cool very slowly?

Because they would otherwise be remarkably brittle, and apt to crack, and even fly into pieces upon the slightest touch of any hard substance.

Why are plate-glass windows superior to those of common glass?

Because the two surfaces of common window-glass are not perfect planes, and not perfectly parallel to each other, as in the case of plate-glass; whence objects seen through the former, appear generally more or less out of shape; and hence comes the elegance and beauty of plate-glass windows; and the singular distortion of things viewed through that swelling or lump of glass which remains where the glass-blower's instrument was attached, and which appears at the centre of certain very coarse panes.

The variation is also thus philosophically explained: "As it is the obliquity between the passing ray and the surface, which, in any case of refraction, determines the degree of bending, a body seen through a medium of irregular surface, appears distorted, according to the nature of that surface."—*Arnott.*

Why is plate-glass so expensive?

Because of the difficulty of producing a perfect

plate, without specks, bubbles, or waves, and the risk of breakage. Its manufacture is as follows:

The materials being fused, are poured upon a hot copper-plate; the mass is then rolled out, annealed, and afterwards polished by grinding with sand, emery, and colcothar.

Previously to 1559 all the glass employed in mirrors was *blown;* when a Frenchman, named Thevart, discovered the art of *casting* it. The art of polishing it was invented by Rivière Dufresny. The French glass for the royal manufactories is now cast at Tourlaville, near Cherbourg, and at St. Gobin an ancient *chateau* near la Fere; it is afterwards sent to Paris to be polished, silvered, and cut. Glasses are finished here to the value of nearly 600*l.* each, and are sometimes 10 feet in height by 6½ in width.

The price of large-sized pier-glasses is within the reach of the most moderate incomes, and there is scarcely a family in France which does not possess one or two; while, as we all know, they are rarely to be met with in England, except in expensively furnished houses.

Why was the black oxide of manganese formerly called glass soap?

Because it cleanses certain impurities, and especially the green tinge which is apt to arise from impure alkali.

Why do glass-cutters use the point of a diamond for dividing and shaping their panes?

Because diamond is the hardest of known substances, and cuts or scratches every other body.—*Arnott.*

Glass can, however, only be cut by the *natural* point of the diamond. There are various other methods of cutting glass, among which the following, from a French Journal, merits notice.

If a tube, or goblet, or other round glass body is to be cut, a line is to be marked with a gun-flint, having

a sharp angle, an agate, a diamond, or a file, exactly on the place where it is to be cut. A long thread, covered with sulphur, is then to be passed two or three times about the circular line, and is to be inflamed and burnt; when the glass is well heated, some drops of cold water are to be thrown on to it, when the pieces will separate in an exact manner as if cut with scissors. It is by this means that glasses are cut circular into thin bands, which may either be separated from, or repose upon, each other at pleasure, in the manner of a spring.

Why is the white enamel in imitative gold trinkets of such little value?

Because it is merely glass rendered more or less milky or opaque, by the addition of oxide of tin; it forms the basis of many of the coloured enamels, which are tinged with the metallic oxides.

Why are leaden bullets let fall on glass cooled in the open air, without breaking it, whereas a few grains of sand also let fall on the glass would break it into a thousand pieces?

Because the lead does not scratch the surface of the glass; while the sand, being sharp and angular, scratches it sufficiently to break it.

Why are glass-house cinders, or clinkers, employed in hydraulic mortar?

Because they contribute to its rapid consolidation. This advantage was employed in the construction of the bridge of Louis XVI. at Paris, and in building the jetties and fort at Cherbourg.

POTTERY.

Why is common clay of a brownish colour?

Because of the oxide of iron which it contains.

Why is nickel prized by the French manufacturers of porcelain?

Because its oxide affords them a very delicate grass-

green, and like other metallic colours this bears the intense heat of their ovens without injury. A hyacinthine colour may be given to flint-glass by melting it with this oxide.—*Parkes.*

Why is manganese serviceable in the arts?

Because its oxides are used in preparing bleaching liquor; in purifying glass, (for which purpose, according to Pliny, it was employed two thousand years ago); in glazing black earthenware; and colouring porcelain enamels.

Why are the Staffordshire potteries concluded to be of Roman origin?

Because evident remains of Roman potteries have been repeatedly discovered, at a considerable depth below the present surface of the land.

The better kinds of pottery, called in this country, *Staffordshire ware*, are made of an artificial mixture of alumina and silica; the former obtained in the form of a fine clay from Devonshire chiefly; and the latter consisting of chert or flint, which is heated red hot, quenched in water, and then sifted to powder. Each material, carefully powdered and sifted, is diffused through water, mixed by measure, and brought to a due consistency by evaporation: it is then highly plastic, and formed upon the potters' wheel or lathe into various circular vessels, or moulded into other forms, which, after having been dried in a warm room, are enclosed in baked clay cases, resembling bandboxes, and called *seggars*; these are ranged in the kiln, so as nearly to fill it, leaving only space enough for the fuel; here the ware is kept red hot for a considerable time, and thus brought to the state of *biscuit.* This is afterwards *glazed*, which is done by dipping the biscuit-ware into a tub containing a mixture of about 60 parts of litharge, 10 of clay, and 20 of ground flint, diffused in water to a creamy consistence, and when taken out enough adheres to the piece to

give an uniform glazing when again heated. The pieces are then again packed up in the seggars, with small bits of pottery interposed between each, and fixed in a kiln as before. The glazing mixture fuses at a very moderate heat, and gives an uniform glossy coating, which finishes the process, when it is intended for common white ware.

The manufacture of Worcester porcelain is described as follows: The siliceous and other substances are first pulverized by an iron roller, which weighs upwards of two tons, and revolves in a groove not unlike that of a cider-mill; after this they are calcined, and then ground at the water-mill, sufficiently fine to filter through sieves, through which no particle of greater dimensions than the 57,000th part of an inch can pass. The composition then, in its liquid state, is dried upon the slip kilns till it becomes of the consistency of clay, when it is taken to the throwing-room, where the ware is first formed; and from thence to the store-room, in which it is placed to dry gradually, thus preparing it for turning and pressing. The articles being applied to the latter are diminished in thickness about one half: the ware is then put into the first set of kilns, called Biscuit Kilns, in which it is burned nearly sixty hours. Having passed through these kilns, such pieces as have been warped by too great heat, are reburned in the second. After this the articles are prepared for receiving their glazing, which accomplished, they are a third time committed to the fire,—and when the glaze is sufficiently vitrified, they are taken out, and when cool, receive their finest embellishment in the painting-room; they are then, a fourth time, condemned to the furnace, for the purpose of incorporating the gilding and the colours with the glaze, after which they are burnished for the market.

Why are the patterns upon ordinary porcelain chiefly in blue?

Because of the facility of applying cobalt. These

patterns are generally printed off upon paper, which is applied to the plate or other article while in the state of biscuit, and adheres to the surface when heat is properly applied.

Why are gum-water and borax used in gilding porcelain?

Because, upon the application of heat, the gum burns off, and the borax vitrifying upon the surface causes the gold firmly to adhere; it is afterwards burnished.

Why ought the materials for porcelain to be selected with the greatest caution?

Because it is necessary that the compound should remain perfectly white after exposure to heat; that it should endure a very high temperature without fusing, and at the same time acquire a semi-vitreous texture and a peculiar degree of translucency and toughness. These qualities are united in some of the oriental porcelain, or *China*, and in some of the old Dresden, but they are rarely found co-existent in that of modern European manufacture. Sèvres and Worcester porcelain is extremely white and translucent, but it is more apt to crack by sudden changes of temperature, more brittle, and, consequently, requires to be formed into thicker and heavier vessels; and more fusible than the finest porcelains of Japan and China. Painting on porcelain or in enamel is an art of great difficulty, and with every care there are frequent failures: hence the costliness of fine porcelain.

The Sèvres porcelain manufactory is in a village of that name about two leagues from Paris. It was purchased by Louis XV. in 1759, and has since been the property of the French Government. Here was made a complete service for Louis XVI. of which each plate cost 25*l.* and in the Tuilleries is a Sèvres vase which cost 1000*l.* In 1801, Brogniart, the distinguished geologist, was appointed director, and to his exertions

the establishment is principally indebted for its celebrity since the Revolution.

According to Professor Silliman, the porcelain of America bids fair to rival that of the old world. Speaking of a manufactory in Philadelphia, he says: "the porcelain is very beautiful in all the principal particulars: in symmetry of modelling, in purity of whiteness, in the characteristic translucence, in smoothness and lustre, and in the delicacy and richness of the gilding and enamel painting. That it rivals the finest productions of Sèvres itself, it is not necessary to assert; but it certainly gives every assurance, that if properly supported, it will not fail to meet every demand of utility and taste, which this great and growing country, may present." The raw material is very abundant near Philadelphia, and in many other parts of the United States.

Why is Wedgwood-ware so called?

Because it was the invention, or rather improvement of Mr. Wedgwood, who, for that purpose brought modellers from Italy and other parts of the Continent, and employed a competent chemist to superintend his experiments. By this means, he not only excluded the foreign manufacture from the market, but also supplied a large quantity for exportation, extending the business far beyond all former example.

LINEN, COTTON, ETC.

Why is linen believed to have been originally manufactured in Egypt?

Because of its frequent mention in the books of Moses, the most ancient of the Scriptural writers. The original Hebrew, not, however, specifying the substance of which the cloth called in the version, linen, was formed, would be only slight evidence of the manufacture of *flaxen* cloth in Egypt at that period, were it not from thence that it was first obtained, and thence only that Europe was for a long time supplied with it. Mummies are also generally found swathed in linen;

and, as the art of preserving bodies in that manner was practised in Egypt in the remotest ages, there can be no doubt that linen was made there at an æra of very great antiquity.

Why did the manufacture of linen make but little progress in Europe during the middle ages?

Because it was confined, both then and for a long period afterwards, to private families, where the thread was spun, and the web was wove for domestic use; and its scarcity as an article of apparel, has been considered as one of the chief causes of the leprosy. Linen, indeed, seems to have been earlier adopted as a luxury for the table than the person, and we read of its being used at banquets long before it was known as an article of dress.

Why is the newly invented French "papier linge" so called?

Because it consists of a paper made to resemble damask and other linen so cleverly, that it is impossible, without examination, to detect the difference; and even to the touch, the articles made from the *papier linge* are very much like linen, and are used for every purpose to which linen is applicable, with the exception, of course, of those in which strength and durability are required. The price is very low: a napkin costs only five or six centimes, (about a half-penny) and when they are dirty, they are taken back at half-price.

Why is it conjectured that fine India cottons were used in ancient Rome?

Because there was a regular commercial intercourse established through the medium of Egypt between Rome and India, the chief part of which was on the coast of Malabar, (which has been ever considered as the greatest manufacturing district of the East) where the art of weaving was practised at the remotest period of which we have any account. Mr. Gifford, in a note to his translation of *Juvenal*, tells us, that the "*serica*

vestes were what we call fine cottons, imported into Europe in Juvenal's time, as they were ages before, from India, through the country of the Seres, the modern Bochara:" and this is strongly corroborated in the *Georgics* of Virgil, which seem evidently to allude to the cotton plant:

> Of Æthiop's hoary trees and woolly wood,
> Let others tell: and how the Seres spin
> Their fleecy forests in a slender twine.
>
> *Dryden's Translation.*

Among the Greeks and Romans, spinning was the chief employment of the women: the rites of marriage directed their attention to it; and the distaff and fleece were not only the emblems but the objects of the most important domestic duties of a wife. The machinery employed in weaving, though perhaps rude in its construction, was, in principle, similar to that still in use; and the process of fulling and preparing the cloth, seems to have resembled the modern practice in every particular point, except that of shearing the nap, with which the ancients do not appear to have been acquainted. In early records we do not, however, read of cloth being measured, which appears to have arisen from a custom of weaving no more cloth in one piece than was sufficient to form a single dress.

Muslins are to this day manufactured by the primitive loom in India, probably without alteration of the form in use during the earliest ages of its invention. It consists merely of two bamboo rollers, one for the warp, the other for the web, with a pair of geer, and the shuttle performs the office of the batton. This simple apparatus, the Indian weaver frequently erects under the shade of a tree. He digs a hole large enough to contain his legs, and the lower part of his geer; he then stretches his warp, by fastening the rollers at due distances in the turf, and suspends the ballances of the geer from the spreading branches of the tree; two loops beneath the geer, into which he inserts his great

toes, serve instead of treddles; and with his long shuttle, he draws the weft, throws the warp, and afterwards closes it up to the web. The spinning is still performed by the ancient operation of the distaff. —*Beckmann.*

Why is woollen a less advantageous manufacture than cotton?

Because wool undergoes great waste in the process of being made into cloth, by scouring and shearing which may be taken at one half, and the expense is greater, whilst cotton incurs no waste of importance. In 1819 the consumption of cotton in Great Britain was 428,500 bags; in 1822, 550,800; in 1825, 615,940; in 1827, 662,900; and in 1828, 732,700; by which it appears that the consumption was nearly doubled within ten years.

The average fineness of cotton may be taken at twenty hanks to the pound; and, as each hank is 840 yards, or nearly half a mile, every pound is nearly ten miles; and the whole, about 400,000 miles, are produced in about sixty-six working hours. In round numbers, this is 6000 miles per hour, or 100 miles a minute. Every fibre passes through no less than ten sets of machinery; hence the united spindles and threads travel through 1000 miles a minute. The noise of their united frictions and collisions, and the united hum of thousands of little spindles, each revolving 4000 miles a minute, may therefore be accounted for.

The estimated number of looms propelled by water and steam power, in the United Kingdom, is 58,000. The average produce, taking it at twenty-two square yards a day, makes 1,254,000, or 1,741 yards a minute; weekly, 7,524,000; monthly, 31,300,000; yearly, 376,200,000. Allowing six yards to each person for yearly consumption, will supply 62,700,000, and will cover 62,700 acres of ground, and in length would extend 213,750 miles, and reach across the Atlantic Ocean seventy-one times.—*Manchester Journal.*

Among the wonders of this branch of manufacture

the following deserve mention. In 1745, a woman at East Dereham, in Norfolk, spun a single pound of wool into a thread of 84,000 yards in length, wanting only eighty yards of forty-eight English miles; which, at that period, was considered as a circumstance of sufficient curiosity to merit a place in the records of the Royal Society. Since that time, however, a young lady of Norwich has spun a pound of combed wool into a thread of 168,000 yards, and she actually produced from the same weight of cotton a thread of 203,000 yards, equal to upwards of 115 English miles:—this last thread, if woven, would produce about twenty yards of yard-wide muslin. Even our young readers may remember the eccentric triumph of Sir John Throgmorton, who sat down to dinner wearing a coat which had that morning been wool on the sheep's back.

Why is the spinning-frame superior to the jenny?

Because, though the *spinning-jenny* invention, in 1767, by Hargreaves, a carpenter, at Blackburn, in Lancashire, gave the means of spinning twenty or thirty threads at once, with no more labour than had been previously required to spin a single thread,—the thread spun by the jenny could not be used except as weft, being destitute of the firmness or hardness required in the longitudinal threads or warp. Mr. Arkwright supplied this deficiency by the invention of the *spinning-frame*, that wonderful piece of machinery, which spins a vast number of threads of any degree of fineness or hardness, leaving to man merely to feed the machine with cotton, and to join the threads when they happen to break. It is not difficult to understand the principle on which this machine is construeted, and the mode of its operation. It consists of two pairs of rollers, turned by means of machinery: the lower roller of each pair is furrowed or fluted longitudinally, and the upper one is covered with leather; to make them take a hold of the cotton. If there were only one pair of rollers, it is clear that a carding of cotton, passed between them,

would be drawn forward by the revolution of the rollers; but it would merely undergo a certain degree of compression from their action. No sooner, however, has the carding, or *roving*, as it is technically termed, began to pass through the first pair of rollers, than it is received by the second pair, which are made to revolve with (as the case may be) three, four, or five times the velocity of the first pair. By this admirable contrivance, the roving is drawn out into a thread of the desired degree of tenuity, a twist being given to it by the adaptation of the spindle and fly of the common flax-wheel to the machinery. Such is the principle on which Mr. Arkwright constructed his famous spinning-frame. It is obvious that it is radically different from the previous methods of spinning, either by the common hand-wheel or distaff, or by the jenny, which is only a modification of the common wheel. Spinning by rollers was an entirely original idea. Mr. Arkwright stated that he accidentally derived the first hint of his great invention from seeing a red-hot iron bar elongated by being made to pass between rollers; and though there is no mechanical analogy between that operation and the process of spinning, it is not difficult to imagine that by reflecting upon it, and placing the subject in different points of view, it might lead him to his invention.*—*Ency. Brit.*

Why is the spinning mule so named?

Because it is a compound of the machinery used in the hand-jenny and water-frame.

Why is cambric so called?

Because it was first manufactured at Cambray in France.

* Mr. Arkwright's machines, on their first introduction, were reckoned adverse to the interests of the working-classes, and repeated attacks were made on the factories built for them; yet the result has shown the absurdity of these prejudices. It is doubtful whether 30,000 persons were employed in all the branches of the cotton manufacture at the above period; whereas, in consequence of those very inventions which the workmen endeavoured to destroy, there are now upwards of 1,000,000 directly engaged in its different departments.

Why may Rouen be considered the Manchester of France?

Because it is the great seat of the cotton manufactures, containing nearly 200 factories, employing from 55 to 60,000 persons. The proximity of Rouen to Havre-de-grace, the great American port, gives it the same advantage, in point of situation, as Manchester derives from being near Liverpool.

Why does netting differ from knitting?

Because the first is performed by knotting into meshes that cannot be unravelled; while the second is, by a certain arrangement of loops so connected with each other as to be highly elastic without separation, yet capable of being unravelled, and having the same thread applied to any other use.

Why has it been conjectured that knit-stockings were invented in Scotland?

Because the earliest account of this kind of knitting is traced in a patent granted in France to a guild of knitters, who chose St. Fiacre, a *Scotchman*, for their patron.

The introduction of knitting into this country, is however, involved in much controversy. Howell says that "Henry VIII. wore, ordinarily, cloth hose, except there came from Spain, by great chance, a pair of silk stockings. King Edward, his son, was presented with a pair of long Spanish silk stockings, by Thomas Gresham, his merchant." But, that woollen stockings were not only in use, but perhaps knit in this country, during the reign of Henry VIII. seems placed beyond doubt by this authentic household record:—

"1533. 25 H. 8. 7 Sept.—Peyd for 4 peyr of knytt-hose, viii *s*.
"1538. 30 H. 8. 3 Oct.—Two peyr of knytt-hose, i *s*."

The invention of the stocking-loom is thus recorded in the inscription to an old painting of one in the Stocking Weavers' Hall, London:—"In the year 1589, the ingenious William Lee, Master of Arts of St. John's College, Cambridge, devised this profitable art for stock-

ings, (but being despised, went to France,) yet of iron to himself, but to us and others of gold: in memory of whom this is here painted."—Seven of Lee's workmen returned to England, and with another laid the foundation of the stocking manufactory in this country, where, in 1663, the masters were incorporated by letters-patent. In their petition the machine is described as consisting of two thousand parts, and making, almost instantaneously, two hundred meshes.

The formation of the *Society of the Stocking* at Venice, in 1590, implies its antiquity on the continent.*

Why are Angola hose preferred for their superior warmth?

Because they combine worsted and cotton in the closest intermixture of the fibre. The separate materials are first passed through a machine called a picker and blower, to clean and lighten the wool or cotton, so that half an ounce will fill a bushel measure. These are then carded together, by which the intermixture is effected, part of each material being dyed blue and black. It is then spun of various fineness by throstles and mules.

Why does the knitting of thread-lace differ from that of stockings?

Because, in making stockings, only one thread is employed, and that in one uniform way; whereas, lace is formed of as many threads as the pattern and breadth require.

Why does lace exhibit various patterns?

Because the pattern is drawn on a piece of parchment, and fastened to the cushion of a circular box with pins formed on purpose, which are stuck through it in various places, according to the design intended to be represented; the requisite number of threads are then wound upon a small bobbin, one end being tied to each pin, and these are thrown over and under each

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* See Part III. Origins and Antiquities, p. 57.

other in various ways; so that the threads twine round the pins, and thus form the multiplicity of holes or eyes which produce the desired figure.

Why is some knit-lace called point?

Because it has been worked, or embroidered, with the needle: when formed of silk, it is called *blonde*.

Why was cotton-lace formerly in such disrepute?

Because the quality of lace depends on its transparency, and at first, the meshes of cotton were encumbered with loose fibres, which destroyed its clearness; and to remove these, for some years appeared to be an insuperable difficulty.

Why is lace "gassed?"

Because the flame of the gas may penetrate the meshes, and free them of these loose fibres, which is done without the smallest injury to the fabric. The apparatus of Mr. Hall, of Nottingham, for the purpose of *gassing* lace, is thus described:—He exposes the lace to a horizontal tube, provided with a series of orifices, through which ascends carburetted hydrogen gas, which, lighted at one end, takes fire through the entire lengths of the tube, making a delicate blue flame, about half-an-inch high. This is supported by the oxygen of the atmosphere; but the oxygen is drawn to the flame by a cap, the whole length of the horizontal tube; and the cap is exhausted by its connexion with an air-pump, of extraordinary dimensions, worked by machinery: hence a brisk current of air constantly passes over the inflamed hydrogen. At the same time, stop-cocks and valves are so provided, as to regulate both the emission of the hydrogen gas, and the exhaustion of the gas above it. A similar tube, with orifices, and a cap, is laid at about a foot distance from the other, and then by means of rollers on each side, the lace is carried through the two lines of flame, and being returned again, the operation is complete. The several machines, as well as the exhausting pumps, are worked by water power.—*Sir R. Phillips's Tour.*

Why does ordinary weaving differ from lace-weaving?

Because it has the warp perpendicular instead of horizontal; and, instead of the shuttle moving at right angles, brass bobbins, in brass carriages of very curious and delicate structure, are made to pass in cross directions round the warp threads obliquely, so as to produce the hexagonal meshes. In truth, the principle of the machine is to produce the very same result as is effected by the evolutions of the bobbins on the pillow or cushion in hand lace-making.

Weavers, or lace-machine hands, are paid by the number of holes, or meshes, which run from 320 to 520 the square inch. The estimate is made by the rack, or 240 holes lengthways, for which they receive, according to breadth, from threepence to eightpence per rack.

WOOLLENS.

Why was Spanish wool formerly so valuable?

Because it was the produce of the original stock, from which the whole of the Merino sheep now in existence have been drawn. This was from a flock transported from the Coteswold Hills in Gloucestershire, to Castile, in 1464. Until within these few years, the only fine wool known was the Spanish wool, which, at that time, was supplied to England, France, and the Netherlands, for their fine cloth manufactures. But the ravages of war destroyed many flocks, and the original system of keeping the sheep was lost, so that the wool has degenerated into a quality not worth more than one-third of the same stock of sheep in Germany.

Why has Saxony become so celebrated for its wool-trade?

Because the late King of Saxony, when Elector, introduced the breed of Merino sheep into Germany, which has since transferred the valuable trade in fine wool, almost wholly from the Spanish to the German soil. Thus, Germany realized in 1829, the sum of

£5,199,934. by the growth of wool, instead of the worthless hair produced upon the old indigenous sheep of the country, which was scarcely in sufficient quantity to supply the peasantry with worsted petticoats and stockings. Of the above quantity, there were imported into England, 23,110,822 lb. of wool, which averaged at 1*s*. 6*d*. per pound, makes a return of £1,733,311. 13*s*. There is likewise a growing prospect of a supply of Merino wool, equal to the consumption of Great Britain, being produced from her two colonies of New South Wales and Van Dieman's Land.

Why is foreign superior to British wool?

Because abroad the wool is grown without seeking any other result than wool,—whereas, in England, the farmer sacrifices every advantage of quality in the wool, to the necessity of exposing the sheep to inclement weather on the fallow land; and to the production of a fine fat carcass—both of which are incompatible with anything like excellence in the quality of the wool. If these motives did not exist, the sheep would then be kept *for their wool;* but under so very different a mode of treatment, as to place it on a level with the Merino wool of Germany.

English historians generally attribute the establishment of the woollen manufactures in this country to the reign of Edward III., but according to the Exchequer records, there were several guild fraternities of weavers established here so early as the middle of the twelfth century. Beyond this, Gervase of Canterbury, who wrote about the year 1202, says, when speaking of the inhabitants of Britain, that "the art of weaving seems to be a peculiar gift bestowed upon them by nature."

Why is it inferred that the finest wool might be grown in England?

Because in this country every circumstance attending the breed and mode of keeping sheep, is favourable

to a most extensive growth of wool; as exposure to the changes of the atmosphere, and the extreme richness of their food, both tend to increase the weight of covering on the animals. The average weight of a fleece of the German Merino breed, is somewhere about 2¼ to 3 pounds; whilst that of a fat Leicester sheep is from 8 to 9 pounds.

In Russia, an instrument called a wool-measure, has lately been invented, by aid of which, the breeders of sheep who desire to improve their stock, may choose, by the fineness of their wool, the best rams to breed from: they may even ascertain the different degrees of the fineness of the wool, in different parts of the body of an animal, or if a single hair be of the same diameter throughout its whole length; the measure being divided into one-hundred-thousandth part of an inch.

Why does the prosperity of the wool-trade in France, depend on the exertions of the agriculturists to ameliorate the quality of the fleeces?

Because the French government encourage the exclusive use of their own wool, by heavy duties on the raw material of other countries; and, accordingly, nearly four-fifths of the wool consumed in France is of native produce.

Why was the woollen manufacture of France so prosperous under Louis the Fourteenth?

Because Colbert, the famous minister of that day, persuaded the king to offer a bonus of 2,000 *livres* for each loom at work, and to permit the nobility to enter into manufacturing speculations without derogating from their rank.

Why does each country of the earth produce its own peculiar wool or cloth?

Because every one has some breed of sheep or other, either indigenous to the climate, or naturalized by the inhabitants from some other part. Of these there is an endless variety, each producing a different quality

of wool, from the extraordinarily fine Merino wool, grown in Silesia, down to the coarse, harsh, and brittle clothing of the sheep in tropical climates.

Why have the Gobelin manufactories become so celebrated?

Because they were originally established by Jean Gobelin, upon the river Bièvre, near Paris, the water of which is considered very favourable to the process of dyeing. The family of Gobelin were, however, only dyers, although their name became attached to the quarter in which they lived, and even to the above river. They soon became rich, renounced their trade, and filled various offices in the public service.

Why were the Gobelin tapestries so named?

Because the successors of the Gobelins not only dyed wool, but made tapestries. Formerly works of this kind were confined to Flanders, where the celebrated tapestry after Raphael's Cartoons was executed; but, at present, there is no manufactory equal to that of the Gobelins.

Why are the carpets of the Gobelins and the Savonnerie so highly prized?

Because of the length of time required to perfect them; sometimes five or six years. They are seldom valued at less than £200 or £300 each. The largest carpet ever made at *la Savonnerie*, is probably that manufactured for the gallery of the Louvre. It consists of seventy-two pieces, and is more than 1,300 feet in length.

In carpet weaving, the wool passes through seventeen processes or sets of hands, to produce the warp. Thus, the fleece wool is sorted; then scoured; and combed by machine or hand. It is then run through a breaking frame and carding-engine; thence it is carried to various drawing frames, to produce regularity in the combined fibres; it is then made into a roving, and carried to the spinning-frame and made into single-

worsted; afterwards double; and then ready for scouring and dyeing, warping and weaving.

Why are Cashmire shawls so successfully manufactured in France?

Because the breed of the Thibet goats has been naturalized there; and the French wool supplies the place of the oriental so perfectly, that all smuggling from India is at an end.

It is said that these shawls were brought into use by the officers of the army of Egypt after their return from the expedition so fatal to the Mamelukes, from whom a large quantity was captured. The rage then began among the French ladies for these beautiful articles, but their very high prices, as well as that of the wool of which they are made, prevented them for some time from being common. The raw material is supplied by the goats which browse on the plains of Khirgiz, whence it is brought to Moscow for sale, and it is calculated that a pound of this genuine wool, which hardly suffices for the chain of a shawl, cannot be imported thence into France, washed, picked, and spun, for less than 150 francs, 6*l.* 5*s.*

Why is bombazeen so called?

Because of its corruption from *bombycina*, the Latin name for stuffs composed of a mixture of silk and woollen; and this term is from *bombyx*, silkworm, and *Sinæ*, China.

SILK.

Why was silk so little used among the Romans?

Because the Roman authors were altogether ignorant of its origin; some supposing it to be grown on trees, as hair grows on animals, others that it was produced by a small fish, similar to the mussel, which is known to throw out threads for the purpose of attaching itself to rocks; others that it was the entrails of a sort of spider, which was fed for four years with paste, and then with the leaves of the green willow, till it burst

with fat; and others that it was the produce of a worm which built nests of clay and collected wax.

Why is it said that we are indebted to the bigotry of former times for our present improved silk manufactures?

Because, in the year 1686, nearly 50,000 manufacturers fled from France, took refuge in England, in consequence of the revocation of the Edict of Nantz, by Louis XIV. who thus, as Pennant observes, sent thousands of the most industrious of his subjects into this country, to present his bitterest enemies with the arts and manufactures of his kingdom: hence the origin of the *silk trade* in Spitalfields. It appears, however, that there was a company of silk women in England so early as the year 1455; but these were probably employed in needleworks of silk and thread. Italy supplied England and all other parts with the broad manufactories till 1489. In 1620 the broad manufacture was introduced into this country; and in 1686 the company of silk-throwsters employed above 40,000 persons.

As a specimen of individual enterprise in this branch of manufacture, we must notice Sir Thomas Lombe, who, about the year 1724, erected in an island on the Derwent, near Derby, a curious mill for the manufacture of silk, the model of which he had brought from Italy, at the hazard of his life. This machine was deemed so important, that, at the expiration of Sir Thomas's patent, parliament voted him 14,000*l.* for the risk he had incurred, and the expense attending the completion of the machinery. This contained 26,586 wheels; one water wheel moved the whole, and in a day and night it worked 318,504,960 yards of organized silk. Such, however, is the march of ingenuity, that Sir Thomas's famous machinery has not been used at Derby for some years, but improved machinery, which performs twice the work, in less room, is now adopted.

Why is silk one of the most important of manufactures?

Because it furnishes subsistence to several millions of human beings; since there is scarcely an individual in the civilized world who has not some article of silk in his possession.

The perseverance of our manufactures has enabled them to ship British Bandana handkerchiefs for India, a circumstance which was triumphantly mentioned by the late Mr. Huskisson, in the House of Commons, about two years since. They have also been exported to France, in considerable quantities.

In the printing of silk handkerchiefs there has been considerable improvement during the last few years. Most of the India handkerchiefs are now printed in England. Some of the blocks display first-rate ingenuity; the patterns or subjects having all the attractions of engraved prints. Thus, it will be curious, a few years hence, to see the wonders of our times, as the Thames Tunnel, &c. and the political characters of the present day, treasured up in the cabinets of the curious, on pocket-handkerchiefs. Yet the idea is only a refinement of the old plan of printing the alphabet, and cuts of nursery stories, on cotton handkerchiefs, for children; the silk prints being but for "children of a larger growth." We believe the public are indebted for these amusing embellishment to the ingenious Mr. Applegath, of Crayford, Kent, whose patent improvements in block-printing, generally, deserve more space than we can here devote to them.

END OF PART X.

KNOWLEDGE FOR THE PEOPLE:

OR THE

PLAIN WHY AND BECAUSE.

PART XI.—CURIOUS CUSTOMS.

CURIOUS CUSTOMS.

CHRISTENING.

Why is baptism supposed to have had its origin from the Deluge?

Because it might commemorate the world having been purged by water. Such is the opinion of Grotius. The Jews practised this ceremony on their proselytes after circumcision, long before the coming of Christ. In the primitive times, the ceremony was performed by immersion, as it is to this day in the Oriental churches, agreeably to the original signification of the word, which means dipping or plunging.

Why was clinic, or death-bed baptism, formerly common?

Because it was the doctrine of many of the fathers, that baptism washed away all previous sins, and that there was no atonement for sins committed after baptism. On this account many deferred that sacrament till they were arrived at the last stage of life, and were pretty safe from the danger of sinning any more.

Why is a certain part of a church called the Baptistery?

Because it is the place where baptism is administered, and sometimes the vessel in which the water for this ceremony is held. Baptisteries are generally appendages to churches; but the most splendid are in-

sulated buildings. Pisa has a celebrated baptistery, which was begun in 1158, and finished in eight years, by Dioti Salvi, an architect of that city. In the middle of this building is an octagonal basin or font, beautifully sculptured, and large enough for the entire immersion of infants in baptism. It does not appear that any building devoted expressly to baptism was ever erected in Great Britain; but the nearest approach to those of Italy is that of Ely.

Why is the font so called?

Because it is the *fons*, (Latin) spring, or fountain, containing the baptismal water. Great Britain can boast of many ancient fonts. That of Bridekirk, in Cumberland, is of Danish origin. That singular inscription, which, read backwards or forwards, has the same words, occasionally found on the walls of many baptisteries, occurs also very frequently on ancient fonts:

(ΝΙΨΟ ΑΝΟΜΗΜΑΤΑ ΜΗ ΜΟΝΑΝ ΟΨΙΝ.)

This is certainly the happiest instance of that species of composition called *amphisbenæ*, or fabulous serpents, each having two heads, and able to advance either way.

Why, in Scotland, were newly-baptized children passed through a flame?

Because their parents believed they might thus be preserved from the power of evil spirits. The invocation on this occasion was—"Let the flame consume thee now or never." An old Greek custom was for gossips to run round the fire with the infant in their arms.

Why did the ancient Irish, at baptizing their children, only dip their right arms in the water?

Because it was thought the child would then give a deeper and incurable blow. Mr. Brand considers this as a proof that the whole body of the child was anciently commonly immersed in the baptismal font.

We read likewise, that the above people were so

given to war, that the mother put the first meat into her male infant's mouth upon the point of her husband's sword, wishing that it might die "no otherwise than in war or by the sword:" and Mr. Pennant informs us, that, in the Highlands, midwives give newly born babes a small spoonful of earth and of whisky, as their first food. Grose tells us of a superstition, that a child who does not cry when sprinkled in baptism, will not live; and that children prematurely wise are not long-lived, that is, rarely reach maturity; a notion which we find quoted by Shakspeare, and put into the mouth of Richard III. (*see Act III. sc. I.*) Herrick, in his *Hesperides*, has the following charms for children:

Bring the holy crust of bread,
Lay it underneath the head;
'T is a certain charm, to keep
Hags away when children sleep.

Let the superstitious wife
Near the child's heart lay a knife;
Point be up, and haft be down;
(While she gossips in the towne.)
This, 'mongst other mystic charms,
Keeps the sleeping child from harmes.

Why were children, in Northumberland, when first carried by the nurse to visit a neighbour, presented with an egg, salt, and fine bread?

Because an egg was a sacred emblem, and a gift well adapted to infancy; and cakes and salt were used in religious rites by the ancients.

Bryant says, "an egg, containing in it the element of life, was thought no improper emblem of the ark, in which were preserved the rudiments of the future world: hence, in the Dionusiaca, and other mysteries, one part of the nocturnal ceremony consisted in the consecration of an egg; by which was signified the world. This seems to have been a favourite symbol among many nations; and the Persians said that one of their deities formed mankind and enclosed them in an egg. In Chelsea churchyard, we remember the

tomb of Sir Hans Sloane, surmounted with the mystic symbols of an egg and serpent, as emblems of his knowledge and skill. The Jews probably adopted the use of cakes and salt in religious rites from the Egyptians: "And if thou bring an oblation of a meat-offering, baken in the oven, it shall be unleavened cakes of fine flour," &c. *Levit.* ii. 4.—"With all thine offerings thou shalt offer salt."

Why are presents made to newly baptized children?

Because such a custom existed among the Grecians: the fifth day after the child's birth, the neighbours sent in gifts and small tokens.

Baptismal festivals sometimes took place in churches. Strype tells us, that in 1559, at the christening of Sir Thomas Chamberlayne's son, St. Benet's Church, Paul's Wharf, was hung with cloth of arras; and, after the christening, were brought wafers, comfits, and divers banqueting dishes; and Hypocras and Muscadine wine to entertain the guests.

Why are stunted and idiotical children called changelings?

Because it was popularly believed that all the fairy children were a little backward of their tongue, and seemingly idiots; and that such children had been changed by the fairies. Mr. Pennant, speaking of the "Fairy Oak" at Whiteford, relates, that a poor cottager, who lived near the oak, had a child who grew uncommonly peevish; the parents attributed this to the fairies, and imagined that it was a changeling. They took the child, put it in a cradle, and left it all night beneath the tree, in hopes that the *tylwydd tag*, or Fairy family, or the Fairy Folk, would restore their own before morning. When morning came, they found the child perfectly quiet, and so went away with it, quite confirmed in their belief.

Why is a piece of coral, with bells, &c. given to infants to assist them in cutting their teeth?

Because an ancient superstition considered coral an amulet, or defensative against fascination; for this we have the authority of Pliny. It was thought too to preserve and fasten the teeth in men. In a Latin work, date 1536, we read of coral: "Wytches tell, that this stone withstondeth lyghtenynge. It putteth of lyghtenynge, whirlewynde, tempeste, and stormes, fro shyppes and houses that it is in." Steevens, in his notes to Shakspeare, says, "there appears to have been an old superstition that coral would change its colour and look pale, when the wearer of it was sick." Plat, in his *Jewel House of Nature and Art*, says, "Coral is good to be hanged about children's necks, as well to rub their gums, as to preserve them from the falling sickness: it hath also some special sympathy with nature, for the best coral, being worn about the neck, will turn pale and wan, if the party that wears it be sick, and comes to its former colour again, as they recover health." In a very rare old work, date 1621, in a dialogue relative to the dress of a child, we read, the "Corall with the small golden chayne."

Why were plum-cakes given to young children called God's-Kichells?

Because whenever godfathers and godmothers were asked a blessing by their children, they gave them one of these cakes: it is still proverbial in some countries, "Ask me a blessing, and I will give you a plum-cake." We may here notice a remarkable Latin superstition, that if a child's slice of bread and butter be let fall with the buttered side downwards, it is an unlucky omen; if with the other side, lucky.

MARRIAGE.

Why were there formerly "seasons for marriage?"

Because such appear to have been denoted in the almanacks of the year. Thus, in Aubrey's Gentilism, a MS. in the Lansdowne Collection, is the following printed advertisement, apparently cut out

of an old almanack:—"Marriage comes in on the thirteenth day of January; and at Septuagesima Sunday it is out again until Low Sunday, at which time it comes in again, and goes not out until Rogation Sunday; thence it is forbidden until Trinity Sunday, from whence it is unforbidden until Advent Sunday; but then it goes out, and comes not in again till the thirteenth day of January next following." Among the Marriage Customs, he says, "When I was a little boy, before the Civil Wars, I have seen the bride and bridegroom kiss over the bride-cakes at the table. It was about the latter end of dinner; and the cakes were layd one upon another, like the picture of the shew-bread in the old Bibles. The bridegroom waited at dinner."

Why were Cumberland bidden-weddings so called?

Because the bridegroom, with a few of his friends, rode about the villages for several miles round, *bidding*, or inviting, the neighbours to the wedding, on the appointed day; which was likewise advertised in the county newspapers, with a general invitation to visitants. These invitations generally brought together a great concourse of people, who, after enjoying the amusements of the day, made a contribution for the newly-married couple.

Why was the Bid-ale, or Bidder-ale, so called?

Because the Saxon word *biddan* signifies to pray or supplicate, and the *bid-ale* was, when any honest man, decayed in his estate, was set up again by the liberal benevolence and contributions of friends at a feast, to which those friends were bid or invited. It was most used in the West of England, and in some counties called a *Help-Ale*.

There is genuine benevolence in these festive meetings to repair the shattered fortunes of a fallen neighbour: they have fallen into disuse, else why the ill-natured saying, "Fools make feasts, and wise men eat them." In these times, men rather associate in com-

panies for mutual succour, and with the parade of laws; but, much as we admire the virtues which such associations reward, we question whether any Friendly Society ever inculcated so pure a lesson of philanthropy as one of these Bid-ales—these unsophisticated unions of heart and hand—which almost compel one to own, "what the present race have gained in head, they have lost in heart."

This custom exists in Wales, where the party inviting is called the Bidder. Here they advertise and issue circulars, one of which runs thus:

"*June* 27, 1827.

"As we intend to enter the matrimonial state on Thursday, the 17th of July next, we are encouraged by our friends to make a bidding on the occasion, the same day, at the *Butcher's Arms*, Carmarthen, when and where the favour of your good and agreeable company is humbly solicited; and whatever donation you may be pleased to confer on us then, will be thankfully received—warmly acknowledged—and cheerfully repaid whenever called for, on a similar occasion,

"By your most obedient servants,
"John Jones,
"Mary Evans."

Those who accept the invitation generally form part of the procession to church, and in some parts are preceded by a harper or fiddler.

Why is bride-cake used at weddings?

Because of its origin in *confarreation*, or a token of the most firm conjunction between man and wife, with a cake of wheat or barley, from *far*, (Latin) bread or corn. Dr. Moffat tells us, that "the English, when the bride comes from church, are wont to cast wheat upon her head." Herrick says, speaking to the bride:

While some repeat
Your praise, and bless you, sprinkling you with wheat.

In Yorkshire, the bride-cake is cut into little square pieces, thrown over the bride and bridegroom's head, and then put through the ring nine times, and afterwards the cake is laid under pillows, at night, to cause young persons to dream of their lovers. Mr. Douce

says this custom is not peculiar to the North of England, but prevails generally.

Why did the common people break a piece of gold or silver in token of a verbal contract of marriage and promises of love?

Because one half might be kept with the woman, while the other part remained with the man. Gay, in his "What d'ye call it," alludes to this practice.

> Yet, Justices, permit us, ere we part,
> To break this Ninepence, as you 've broke our heart.

> *Filbert: (Breaking the Ninepence)* As this divides, thus are we torn in twain.

> *Kitty: (Joining the pieces)* And, as this meets, thus may we meet again.

Why were certain ideas of good fortune attached to crooked money?

Because, in the preceding custom, the piece broken between the contracted lovers must have been a crooked one. Thus, in *Hudibras:*

> Like Commendation Ninepence crook't,
> With to and from my love is look't.

a circumstance confirmed also in the *Connoisseur*, No. 56, with an additional custom, of giving locks of hair woven in a true lover's knot. "If, in the course of their amour, the mistress gives the dear man her hair woven in a true lover's knot, or breaks a crooked ninepence with him, she thinks herself assured of his inviolate fidelity." This "bent token" has not been overlooked by Gay:

> A Ninepence bent
> A token kind to Bumkinet is sent.

Why was the "contracting cup" so named?

Because, at the above ceremony, the parties drank together, else the contract was void. Thus, in one of Middleton's plays:

> Ev'n when my lip touch'd the contracting cup.

Why was the drinking off candles'-ends long practised by amorous gallants?

Because, as a feat of gallantry, to swallow a candle's end formed a more formidable and disagreeable flap-dragon than any other substance; and, therefore, afforded a stronger testimony of zeal for the lady to whose health it was drunk.

Why is a certain knot, which cannot be loosed, called Gordian?

Because Gordius, (a king of Phrygia Major) being raised from the plough to the throne, placed the harness, or furniture of his wain and oxen, in the Temple of Apollo, tied in such a knot, that the monarchy of the world was promised to him that could untie it; which, when Alexander, "that tumour of a man," had long tried, and could not do, he cut it with his sword. Such, at least, is the ancient story: if not true, it is certainly ingenious.

Why were confarreation and a ring used at weddings?

Because both were used anciently as binding ceremonies by the heathens, in making agreements, grants, &c.; whence they have doubtless been applied to the most solemn of our engagements. We quote this from Brand, who also says, the supposed heathen origin of our marriage ring had well nigh caused the abolition of it during the Commonwealth. Butler, in his *Hudibras*, thus explains the reason why the Puritans wished it to be set aside:—

> Others were for abolishing
> That tool of matrimony, a ring,
> With which th' unsanctify'd bridegroom
> Is married only to a thumb;
> (As wise as ringing of a pig
> That used to break up ground, and dig)
> The bride, to nothing but her will,
> That nulls the after-marriage still.

The antiquity of rings is attested by Scripture. Thus, when Pharaoh committed the government of all Egypt to Joseph, he took his ring from his finger, and gave it to him as a mark of power. The Israelitish women also wore rings, not only on their fingers, but also in their nostrils and ears. In an old Latin work, ascrib-

ing the invention of the ring to Tubal Cain, we find this pretty conceit. "The form of the ring being circular, that is, round and without end, importeth thus much: that their mutual love and hearty affection should roundly flow from the one to the other as in a circle—and that continually and for ever." Herrick has versified this quaintness with great felicity:

And as this round
Is no where found
To flaw or else to sever:
So let our love
As endlesse prove,
And pure as gold for ever.

Mr. Brand notes, "this allusion, both to the form and metal of which the ring is composed, is elegant. Were it not top long, it would be the best *posie* for a wedding ring that was ever devised."

Why is allusion made in the preceding lines, by Butler, to the thumb?

Because the ring was formerly first placed upon the thumb. Thus, in the Hereford, York, and Salisbury Missals, the ring is directed to be put first upon the thumb, afterwards upon the second, then on the third, and lastly on the fourth finger.

Why was a joint ring a common token among betrothed lovers?

Because it denoted their mutual constancy. Dryden, in his play of Don Sebastian, date 1690, has the following beautiful passage on this custom:—

A curious artist wrought 'em
With joynts so close as not to be perceiv'd;
Yet they are both each other's counterpart.
Her part had Juan inscribed, and his had Zayda,
(You know these names were theirs) and, in the midst
A heart, divided in two halves, was plac'd.
Now, if the rivets of those rings, inclos'd,
Fit not each other, I have forg'd this lye:
But if they join, you must for ever part.

Why were Gimmal rings so called?

Because Gimmal is derived from Gemelli, twins, and these rings were twisted together. Again, we find,

in an old English Grammar: "a Gimmal or Gimbal, *i. e.* a double or twisted ring, from Gemellus; hence Gimbal and Jumbal are applied to other things twisted and twined after that manner." Herrick, in his *Hesperides*, mentions a Gimmal ring as a love-token:—

> Thou sent'dst to me a true love knot; but I
> Return'd a ring of Jimmals, to imply
> Thy love had one knot, mine a triple tye.

Why did disaffected lovers return each other's presents?

Because, as a MS. in the Harleian library states, "by the Civil Law, whatsoever is given, *exsponsalitia largitate*, betwixt them that are promised in marriage, hath a condition, (for the most part silent) that it may be had again, if marriage ensue not; but if the man should have had a kiss for his money, he should lose one half of that which he gave. Yet, with the woman it is otherwise, for kissing or not kissing, whatsoever she gave, she may ask, and have it again. However, this extends only to gloves, rings, bracelets, and such like small wares.—*Quoted by Strutt.*

Why did some of the ancients make a ring denote servitude?

Because the bridegroom was to give it to his bride, to denote to her that she is to be subject to him.

Rings appear to have been formerly given away at weddings. Anthony Wood writes that Killey, in 1589, at Trebona, "was openly profuse beyond the limits of a sober philosopher, and did give away in gold wire rings (or rings twisted with thin gold wires) at the marriage of one of his maid-servants, to the value of £4000.

The ring has ever been a favourite subject in amatory poetry: Davison, 1611, has the following beautiful sonnet—

Upon sending his mistress a gold ring, with this poesie.

PURE AND ENDLESSE.

> If you would know the love which I you beare,
> Compare it to the ring which your faire hand

Shall make more precious when you shall it weare;
So my love's nature you shall understand.
Is it of metal pure? so you shall prove
My love, which ne'ere disloyal thought did staine:
Hath it no end? so endless is my love,
Unless you it destroy with your disdaine.
Doth it the purer waxe the more 't is tri'de?
So doth my love: yet herein they dissent,
That whereas gold, the more 't is purifi'de,
By waxing lesse, doth show some part is spent;
My love doth waxe more pure by your more trying,
And yet increaseth in the purifying.

A still more beautiful allusion to the emblematical properties of the wedding ring is quoted by Brand from a collection of poems, date 1801:—

*To S***** D******, with a Ring.*

Emblem of happiness not bought nor sold,
Accept this modest ring of virgin gold;
Love in the small, but perfect circle, trace,
And duty, in its soft, though strict embrace.
Plain, precious, pure, as best becomes the wife;
Yet firm to bear the frequent rubs of life.
Connubial love disdains a fragile toy,
Which rust can tarnish, or a touch destroy;
Nor much admires what courts the general gaze,
The dazzling diamonds' meretricious blaze,
That hides with glare the anguish of a heart
By nature hard, though polished bright by art.
More to thy taste the ornament that shows
Domestic bliss, and without glaring, glows.
Whose gentle pressure serves to keep the mind
To all correct, to one discreetly kind.
Of simple elegance th' unconscious charm,
The holy amulet to keep from harm;
To guard, at once, and consecrate the shrine;
Take this dear pledge—it makes and keeps thee mine.

Why do weak persons prize a much-worn wedding ring?

Because of the old proverb—

As your wedding ring wears,
Your cares will wear away.

This, observes Brand, has often been quoted to encourage and hasten the consent of a diffident and timorous mistress.

Why was the ring placed on the left hand?

Because this hand is much less used than the right,

and therefore the ring was less liable to be bruised or broken. This is from an old Latin author, and we find a similar reply in the *British Apollo*, 1788, and that, "for the same reason, the fourth finger was chosen, which is not only less used than either of the rest, but is more capable of preserving a ring from bruises, having this one quality peculiar to itself, that it cannot be extended but in company with some other finger, whereas the rest may be singly stretched out to their full length and straightness." The rigid notion of married women never putting off the wedding ring, is supposed to have originated in the Popish custom of hallowing the ring, besides the remembrance of the expression "till death us do part," in our marriage service.

Why is the true-love knot so called?

Because of its origin from the Danish verb *trulofa, fidem do,* (Lat.) I plight my troth or faith; a knot among the northern nations being the symbol of love, faith, and friendship, pointing out the indissoluble tie of affection and duty. Sir Thomas Browne, with his usual erudition, says, "the true lovers' knot had, perhaps, its origin from Nodus Herculanus, or that which was called Hercules; his knot resembling the snaky complication in the Caduceus, or rod of Hermes, and in which form the zone or woollen girdle of the bride, was fastened, as Turnebus observes in his Adversaria." Hence, evidently, the bride-favours or top-knots at marriages, which were formerly of various colours.

Why was the bride-cup so called?

Because it was borne before the bride in coming home from church.

Why is the marriage ceremony celebrated with great splendour among the poor as well as the rich Jews?

Because every guest brings a present, chiefly consisting of plate; on which account the lower orders are anxious to invite as many as possible; and not unfre-

quently, when the wedded pair are very poor, these gifts are disposed of immediately, to defray the expense of the feast, and assist the young couple in house-keeping.

The policy of marriage in humble life has been thus illustrated by an acute observer: "There are few labourers of either sex who live to an old age unmarried; scarcely any, it is said, of tolerable character; and this remark may be confirmed by any person's observation."

The witty Selden has three passages on marriage, which we cannot omit.—1. Of all the actions of a man's life, his marriage does least concern other people; yet of all actions of our life, 'tis most meddled with by other people.—2. Marriage is nothing but a civil contract: 't is true, 't is an ordinance of God; so is every other contract, God commands me to keep it when I have made it.—3. Marriage is a desperate thing; the frogs in Æsop were extreme wise; they had a great mind to some water, but they would not leap into the well, because they could not get out again.

Why was Wednesday the chosen day for celebrating Jewish marriages?

Because the Sanhedrin held its sitting on Thursday, and thus the newly married man could immediately bring his wife before them, if he had any ground of complaint. The choice of Wednesday still continues; but the original cause for selecting that day has long ceased to exist. If, however, either of the party has been previously married, Sunday is the day chosen, and music and dancing form no part of the entertainments. The ceremony is performed beneath a canopy, generally of crimson velvet, square, and supported at each corner by four of the persons present; a piece of carpet is spread beneath it, and the bridegroom and bride, the rabbi, and all concerned in the ceremony, stand under it while the contract is read, &c. It is

deposited at the synagogue, and is brought to the house where the wedding is celebrated, by the servants of the synagogue, who carry the canopy back when the ceremony is over.

Why are Gretna Green marriages so named?

Because the first mock priest, by whom this trade was founded, resided on the common or green betwixt Graitney and Springfield, on the borders of Scotland, but removed to the latter place in 1791, where his successors have since resided.

Why are not Gretna Green marriages prevented by the Scottish church?

Because the mock priest or coupler despises the threats of the kirk, as excommunication is the only penalty it can inflict. An attempt was made, in the General Assembly of 1826, to have this shameful system of fraud and profanity suppressed, but without effect. Upon an average, 300 couples are married in the year, and half a guinea is the lowest fee that is ever charged. In its legal effect, the ceremony performed at Gretna merely amounts to a confession before witnesses that certain persons are man and wife; and the reader is aware that little more is required to constitute a marriage in Scotland; a marriage which is perfectly binding in regard to property and the legitimacy of children.

Why were Fleet marriages so called?

Because they were performed in the Fleet-prison, by a set of drunken, swearing parsons, with their myrmidons, that wore black coats, and pretended to be clerks and registers to the Fleet, plying about Ludgate Hill, pulling and forcing people to some peddling ale-house, or brandy-shop, to be married; and even on Sundays stopping them as they went to church. In this way, from October 1704, to February 1705, there were performed in the Fleet, 2954 marriages, without either license or certificate of banns. Pennant, at a later period,

confirms this account of the nefarious traffic. He says, in walking by the prison in his youth, he was often accosted with "Sir, will you please to walk in and be married?" and he states that painted signs, containing a male and female hand conjoined, with the inscription, "Marriages performed within," were common along the building. This glaring abuse continued many years, to the ruin of children and destruction of their parents; and it was only put an end to by the marriage act in 1753.

Why were knives formerly part of the accoutrements of a bride?

Because it anciently formed part of the dress for women to wear a knife or knives, sheathed and suspended from their girdles; a finer, and more ornamented pair of which would very naturally be presented on the occasion of a marriage.—*Brand.* May not ladies having silver trinket knives also be a refinement of this custom?

Why was part of the marriage ceremony performed at the church-porch?

Because of an old law, by which, nowhere else but before the face of, and at the door of, the church, could the marriage dower have been lawfully assigned. Chaucer, who flourished during the reign of Edward III. alludes to this custom in his *Wife of Bath*, thus—

> She was a worthy woman all her live,
> Husbands at the church-dore had she five.

Why is the flower "sops of wine" so called?

Because of its resemblance to the pieces of cake or wafers that were formerly immersed in wine, and drunk at weddings.

Why did the Jews break the glass out of which the bride and bridegroom had drunk?

Because it might admonish them of mortality.

Why is it customary in some ranks to salute the bride the moment the marriage ceremony is concluded?

Because of the ancient nuptial kiss in the church, enjoined by the York and Sarum Missals. So in dancing, a kiss was anciently the established fee of a lady's partner. What would the patronesses of Almacks say to such a custom in these days!

Why does the bride usually wear a veil?

Because of its origin in the Anglo-Saxon custom of performing the nuptial ceremony under a veil, or square piece of cloth, held at each corner by a tall man, over the bridegroom and bride, to conceal her virgin blushes; but if the bride was a widow, the veil was esteemed useless. At Sarum, when there was a marriage before mass, the parties kneeled together, and had a fine linen cloth (called the care-cloth) laid over their heads during the time of mass, till they received the benediction, and then were dismissed.—*Brand.* The canopy used at Jewish weddings has been noticed at page 16.

Why are flowers and herbs strewn before the bride and bridegroom on their way to and from church?

Because they have been fancifully supposed to propitiate the lives of the parties. The association enjoins the love of nature, from which spring the purest delights. Of its antiquity there are innumerable records scattered throughout the pages of our pastoral and dramatic poets. Herrick, in his *Hesperides*, says—

> Glide by the banks of virgins then, and passe.
> The showers of roses, lucky four-leav'd grasse:
> The while the cloud of younglings sing,
> And drown ye with a flowrie Spring.

Who does not remember the pathos of Shakspeare to this purpose:

> Our bridal flowers serve for a buried corse.

In Holland, we read, the laurel is very conspicuous on these occasions, denoting that the wedding-day is one of triumph. In Wales, to this day, some cunning lass slily awaits the approach of the wedding-party, and endeavours to throw a garland over the bride, which, if it fall on her is deemed lucky —but if it does

not, unfortunate.* At the Coronations of our kings, the first person in the procession was a girl strewing flowers. At the recent coronation of our present monarch, the flower-strewing was omitted; but amidst its pageant glories, few attracted more admiration than the chaste dresses of six maids of honour, attendant on the queen: they were of pure white, draped up with garlands of white roses. Thus, the delightful association lingered even amidst a blaze of diamonds. Of these emblematical employments of flowers,—more anon.

Why was rosemary worn at weddings?

Because it was anciently thought to strengthen the memory. Hence, also, it was worn at funerals. For weddings, it was gilded and dipped in scented water. In a curious wedding sermon, (for such were formerly common) by Dr. Hacket, date 1607, the use of rosemary, at this time, is thus set forth:—"Rosemarinus, the rosemary, is for married men; the which by name, nature, and continued use, man challengeth as properly belonging to himself. It overtoppeth all the flowers in the garden, boasting man's rule. It helpeth the braine, strengtheneth the memorie, and is very medicinable for the head. Another property of the rosemary is, it affects the hart. Let this Ros Marinus, this Flower of Men, ensigne of your wisdom, love, and loyaltie, be carried not only in your hands, but in your heads and harts." Dekker thus touchingly alludes to the two-fold uses of rosemary, when speaking of a bride who died of the plague on her wedding day:—"here is a strange alteration, for the rosemary that was washt in sweet water to set out the bridall, is now wet in teares, to furnish her buriall." To conclude, Brand, from whom we have abridged these Notes, also says, that so late as the year 1698, the old

* From an unpretending little volume—*Cambrian Superstitions*, by W. Howells, of Tipton.

country use appears to have been kept up, of decking the bridal-bed with sprigs of rosemary.

Why are nuptial garlands of the most remote antiquity?

Because they were equally used by the Jews and the heathens. Their use in this country is traced to the Anglo-Saxons, among whom, after the benediction in the church, both the bride and the bridegroom were crowned with flowers, kept in the church for that purpose. These garlands were sometimes made of myrtle; and in the time of Henry VIII, the bride wore a garland of corn-ears, sometimes one of flowers. In a work, dated 1493, we find, "the garlande bytokeneth gladnesse, and the dignitye of the Sacrament of Wedlok."

Why are those who have lost their love said to wear the willow-garland?

Because willow was, in ancient days, especially among herdsmen and rustics, *a badge of mourning*, as may be collected from Virgil, in his Eclogues, where the nymphs and herdsmen are frequently introduced, sitting under a willow, mourning their loves. The same occurs in many Greek poets. For the ancients frequently selected, and, as it were, appropriated several trees, as indexes or testimonials of the various passions of mankind, from whom we continue, at this day, to use *rue* and *rosemary* at funerals; these two being representatives of a dead person, and *willow*, of *love dead*, or *forsaken*. The Jews, upon their being led into captivity, *Psalm* cxxxvii, are said to hang their harps upon *willows*, *i. e.* trees appropriated to men in affliction and sorrow, who had lost their beloved Sion.—*British Apollo*, (abridged) 1710.

A willow, also, in *Fuller's Worthies*, (Cambridgeshire) is described as a sad tree, whereof such who have lost their love, make their *mourning garlands*; and we know what exiles hung their harps upon such

doleful-supporters. This tree delighteth in moist places, and is triumphant in the isle of Ely, where the roots strengthen their banks, and lop affords fuell for their fire. It groweth incredibly fast, it being a by-word in this county, that the profits by willows will buy the owner a horse, before that by other trees will pay for his saddle. Let me adde, that if green ashe may burn before a queen, withered willows may be allowed to burne before a lady."

The mention of the willow, in lugubrious poetry, is very frequent: nay, it appears the very emblem of melancholy. Thus, in a volume, date 1657:

A Willow Garland thou didst send
  'T was forsook by thee;
Which did but only this portend,
  'T was forsook by thee.

Since it is so, I' ll tell thee what,
  To-morrow thou shalt see
Me weare the willow, after that
  To die upon the tree.

Again, "To the Willow Tree," in Herrick's *Hesperides*:—

Thou art to all lost love the best,
  The only true plant found,
Wherewith young men and maids distrest,
  And left of love, are crown'd.

When once the lover's rose is dead,
  Or laid aside forlorne,
Then willow-garlands, 'bout his head,
  Bedewed with tears, are worne.

When with neglect (the lover's bane)
  Poor maids rewarded be,
For their love lost, their only gaine
  Is but a wreathe from thee.

And underneath thy cooling shade
  (When weary of the light)
The love-spent youth, and love-sick maid,
  Come to weep out the night.

Why has it been facetiously said, that "Huntingdonshire is a very proper county for unsuccessful lovers to live in?"

Because, "upon the loss of their sweethearts, they will find here an abundance of willow-trees, so that they may either *wear the willow green*, or hang themselves, which they please; but the latter is reckoned the best remedy for slighted love."—*Comical Pilgrim's Travels through England*, 1723.

Why was it formerly customary to present a forsaken lover with a stick or twig of hazel?

Because, probably of the double meaning of the Welsh Cole, signifying *loss*, as well as *hazel-wood*. Of the same sense is the following proverb, supposed to be the answer of a widow, on being asked why she wept: "painful is the smoke of the hazel."—*Owen's Welsh Dictionary.*

Why was the Bride-ale so called?

Because it was derived from the circumstance of the bride's selling ale on the wedding-day, for which she received, by way of contribution, whatever handsome price the friends assembled on the occasion chose to pay her for it.

Why were the Scottish Penny-weddings so called?

Because the expense of the entertainment was not defrayed by the young couple or relations, but by a club among the guests.

Why was it customary to race from the church to the bridegroom's house?

Because whoever first reached the house with the news, won the kail, *i. e.* a smoking prize of spice broth, which stood ready prepared to reward the victor. Probably, however, it was a general advantage at the feast, since Dr. Jamieson thinks kail is used metonimically for the whole dinner, as constituting among our temperate ancestors the principal part. Hence, in giving a friendly invitation, it is common to say, "Will you come and tak' your kail wi' me?" The better feeding English substitute mutton for kail, and the

French invitation is, *Voulez vous venir manger la soupe chez moi.*

Why is it supposed that torches were borne at old English weddings, as in the heathen mythology?

Because of the following lines in Herrick's *Hesperides:*

Upon a Maid that dyed the day she was married.

That morne which saw me made a bride
The ev'ning witnest that I dy'd.
These holy lights wherewith they guide
Unto the bed the bashful bride,
Serv'd but as tapers for to burne,
And light my reliques to their urne,
This Epitaph, which here you see,
Supply'd the Epithalamie.

Why was music formerly common at English weddings?

Because at the marriages of the Anglo-Saxons, the parties were attended to church by music. Bell-ringing is everywhere common.

Why is the cushion-dance so called?

Because it partly consists of women kneeling on a cushion to be kissed by the male dancers. Selden speaks of the "Cushion Dance, and all the company dance, lord and groom, lady and kitchenmaid; no distinction—omnium gatherem, tolly, polly, hoite come toite." The Quintain was also common at weddings. (See Part VI. page 45 of the present work.)

Why do weak persons wish the sun to shine at their wedding?

Because this was once considered a good omen of bright prospects in life. Herrick alludes to this custom:

While that others do divine
Blest is the bride on whom the sun doth shine.

The same class of persons consider rain on the dead at funerals as typical of resurrection

Why was the posset so called?

Because of its origin from the French *poser, rendere,*

(Lat.) to settle; thus, when the milk breaks, the cheesy parts, being heavier, subside. Herrick alludes to the Wedding Sack-posset:

> What short prayers shall be said;
> And how the Posset shall be made
> With cream of lilies, (not of kine)
> And maidens blush for spiced wine.

Why was the Dunmow Flitch of Bacon custom established?

Because Lord Fitzwalter, in the reign of Henry III, ordered, that whatever married man did not repent of his marriage, or quarrel with his wife, in a year and a day after it, should go to his Priory, and demand the bacon—on his swearing to the truth, kneeling on two stones in the churchyard.—*Gent. Mag.*

Memoranda of three claims only are found prior to the Reformation; and Mr. Ellis, in his Notes to Brand, says of just as many since.

The Dunmow Bacon is alluded to in the Visions of Pierce Plowman, and in Chaucer's Wife of Bath's Prologue. A similar custom prevailed at Winchmore, in Staffordshire.

Why is Riding the Stang so called?

Because it consists of riding across a long piece of wood, from the Icelandic *staung, hasta,* (Lat.) a spear or pole, carried by two persons across their shoulders. It was used when a woman had beat her husband; the poor fellow being thus carried; or when he could not be caught, some young fellow being put on the pole to proclaim that it is not on his own account that he is thus treated, but on that of another person, whom he names. Ray tells us, that in his time the word *stang* was used in some colleges at Cambridge; to *stang* scholars in Christmas time, being to cause them to ride on a colt-staff or pole, for missing chapel.

Why is Skimmington Riding so called?

Because it is a sort of burlesque procession of a man

who suffers himself to be beat by his wife; in short, a species of *stanging*. Mr. Douce derives its name from a skimming-ladle, which is carried in the procession; but Mr. Ellis thinks the word Skimmington signifies an arrant scold, and has most probably been derived from the name of some woman of great notoriety in that line.

SOCIAL ARTS.

Why were the internal communications in Britain so materially improved by the Romans?

Because they made excellent roads, which extended through all parts of the empire; some of them can yet be traced in England, running as straight as an arrow; one of these is Watling-street, so often mentioned in history: but after the fall of the Roman Empire, their roads were neglected, and they fell into decay.

Mr. Palgrave observes, with touching simplicity of style, "Many of our Roman cities have become entirely wasted and desolate. Silchester is one of these: corn-fields and pastures cover the spot once adorned with public and private buildings, all of which are now wholly destroyed. Like the busy crowds who inhabited them, the edifices have sunk beneath the fresh and silent green sward; but the flinty wall which surrounded the city, is yet firm, and the direction of the streets may be discerned by the difference of tint in the herbage; and the ploughshare has turned up the medals of the Cæsars, so long dead and forgotten, who were once the masters of the world."

BUILDING, ETC.

Why were the Britons indebted to the Saxons for but few social improvements?

Because "they were so far from having arts, that they could not even build with stone. The church at Glaston was thatched. They lived sluttishly in their houses, they ate a great deal of beef and mutton, and drank

good ale in a brown mazzard, and their very kings were but a sort of farmers. The Normans then came, and taught them civility and building."—*Aubrey, MS.*

Why are beautiful tesselated pavements sometimes discovered underground in England?

Because they are the remains of the colonies formed by the Romans in this country, and peopled with the Roman inhabitants, who came hither from Italy, accompanied by their wives and children. Within the circuit of their fortifications, they built temples, and palaces, and baths, and other splendid structures, accordant with their luxurious habits; which have been destroyed by fire or siege.

Why were so many of the ancient English residences called "Halls"?

Because the chief feature in the interior of each was the great or stone *hall*, which thus gave its name to the whole house. It corresponded to the refectory of the abbey. The principal entrance to the main building, from the first or outer court, opened into a *thorough lobby*, having on one side several doors or arches, leading to the buttery, kitchen, and domestic offices; on the other side, the hall, parted off by a screen, generally of wood elaborately carved, and enriched with shields and a variety of ornament, and pierced with several arches having folding doors. Above the screen, and over the lobby, was the minstrel's gallery, and on its front were usually hung armour, antlers, and similar memorials of the family exploits. The hall itself was a large and lofty room, in shape of a parallelogram; the roof, the timbers of which were framed with pendents richly carved and emblazoned with heraldic insignia, formed one of its most striking features. "The top-beam of the hall," in allusion to the position of his coat of arms, was a symbolical manner of drinking the health of the master of the house. At the upper end of this chamber, furthest

from the entrance, the floor was usually raised a step, and this part was styled the *dais*, or high place. On one side of the dais was a deep embayed window, reaching nearly down to the floor; the other windows ranged along one or both sides of the hall, at some height above the ground, so as to leave room for wainscoting or arrass below them. They were enriched with stained glass, representing the armorial bearings of the family, their connexions, and royal patrons, and between the windows were hung full-length portraits of the same persons. The royal arms usually occupied a conspicuous station at either end of the room. The head table was laid for the lord and principal guests on the raised place, parallel with the upper end wall, and other tables were ranged along the sides for inferior visiters and retainers. Tables, so placed, were said to stand "banquet-wise." In the centre of the hall was the rere-dosse, or fire-iron, against which fagots were piled, and burnt upon the stone floor, the smoke passing through an aperture in the roof immediately overhead, which was generally formed into an elevated lantern, a conspicuous ornament to the exterior of the building. In later times, a wide arched fire-place was formed in the wall on one side of the room. The halls, in fact, of our colleges, at either university, and the inns of court, still remain, as in Aubrey's time, accurate examples of the ancient baronial and conventual halls: preserving, not merely their original form and appearance, but the identical arrangement and service of the tables. Even the central fire is, in some instances, kept up, being of charcoal, burnt in a large brazier, in lieu of the rere-dosse. In other respects, probably little, if any thing, has been altered since the Tudor æra; and those who are curious to know the mode in which our ancestors dined in the reign of the Henrys and Edwards, may be gratified by attending that meal in the great halls of Christchurch or Trinity, and tasking his imagination to convert the principal and fellows

at the upper table, into the stately baron, his family, and guests; and the gowned commoners, at the side tables, into the liveried retainers.—*Quarterly Review.*

The finest specimens are the magnificent hall at Westminster, built by Edward II; and the great hall at Eltham, also probably built by the same monarch, and but little inferior in grandeur to that of Westminster. The Coronation Banquet of George IV, in the latter, was a splendid illustration of the festal purposes for which this spacious hall was erected.

Aubrey, writing in the seventeenth century, thus describes, in his quaint and picturesque way, the characteristics of the old manorial, or hall-houses of the times of the Plantaganets and Tudors. "The architecture of an old English gentleman's house, (especially in Wiltshire and thereabout) was a high strong wall, a gate-house, a great hall, and parlour; and within the little green court, where you come in, stood on one side the barne. *They then thought not the noise of the threshold ill musique.*"

Why would a great hall be inappropriate in a modern residence?

Because such an apartment is now never applied to its ancient purposes, from the total change in domestic habits. Aubrey says, "in the time of Henry VII and VIII, in the hall and parlours there were wrote texts of Scripture, and good sentences on the painted cloths, which does something evidence the piety of those days more than now."

Why is the modern vestibule improperly called a "hall"?

Because it has none of the proportions and appearance of the ancient hall. The idea of fitness and utility is wanting. The room we know not to be applied to the purposes of the old hall, and the association is, therefore, injured, if not destroyed.

Why is the gate of a city called a bar?

Because it is a *bar*-rier. Hence Temple-*bar*, and Holborn-*bar* in London; and the fortified gates in York, &c.

Why were ale-houses and inns but rare in the middle ages?

Because, when men "had a mind to drink they went to the friaries, and when they travelled, they had entertainment in the religious houses, if occasion so long required. The meeting of the gentry was not then in tippling-houses, but in the fields and forests, with their hawkes and houndes, with their bugle-hornes in silk baudrics, &c."—*Aubrey.*

Why were armories common in ancient mansions?

Because the lords or owners might promptly supply their retainers with arms in case of attack. Aubrey tells us that "The halls of justices of peace were dreadful to behold. The screenes were garnished with corslets and helmets gaping with open mouth, with coates of mail, lances, pikes, halberts, brown-bills, battle-axes, bucklers, and the modern callivers, petronells and (in King Charles's time) muskets and pistolls." In these peaceful times, the law affords better security than mere weapons of defence; and armories in private residences have dwindled to a few trusty swords, pistols, and carbines, which may be seen in terrific display over the mantel-piece of the steward's room, as objects of terror, and means of defence against burglars.

Why was it customary to discontinue fires at Easter?

Because the ancient hall fire was discontinued at Easter Day, then called "God's Sondaye." A quaint religious writer, of the date of 1511, thus speaks of this custom. "Ye know well that it is the manner at this daye to do the fire out of the hall, and the black wynter brondes, and all thynges that is foule with fume and smoke, shall be done awaye; and where the fire was shall be gayly arrayed with fayre floures, and strewed with green ryshes all aboute."

Why do we use the expression—to sit round the fire?

Because formerly the hearth was commonly in the middle of the apartment. Hence also, the old saying, "Round about the coal fire." Aubrey wrote, in 1678, "Anciently, before the Reformation, ordinary men's houses, as copyholders and the like, had no chimneys, but flues, like corner-holes; some of them were in being when I was a boy." See also *Chimneys*, in Part III of the present work.

Why in the middle ages did all lords keep trumpeters?

Because, upon any occasion of bustling, a great lord summoned those that held under him by the sound of trumpet; those again sounded their trumpets, and so downwards to the copyholders and villeins.

Why is the manufacture of bricks and tiles supposed to have been known in England at an early period?

Because it was practised in such perfection by the Romans, during their occupation of the island, as is evident in the numerous remains of their buildings. It has, however, been asserted, that up to the reign of Elizabeth, the houses of the gentry throughout England, were built entirely of timber; whereas, of the mansions of earlier date than that reign, which remain entire or in part to this day, three-fourths at least are built of stone or brick. The latter material is stated by Bagford and others, to have been first introduced in the reign of Henry VII. Yet Endure Palace, in Oxfordshire, erected by William Delapole, and Hurstmonceaux Castle, in Sussex, both of which are of brick, are attributed to the reign of Henry VI. Oxburgh Hall, in Norfolk, was erected in the reign of Edward IV. Leland mentions the walls of Hungerford, as early of Richard II, being of that material; and Stow says, that Ralph Stratford, Bishop of London, enclosed the burial-ground in the Charter House, for those that died of the plague in 1348, with a wall of brick. That roofing tiles were in use before the

time of Richard I, is proved by the order made in the first year of that reign, Henry Fitzalwayne being Lord Mayor of London, that the houses of that city should be covered with 'brent tyle,' instead of 'strawe' or reeds.

The ancient name for bricks appears to have been wall-tiles, to distinguish them from floor-tiles, used for paving.

Why did James I. enforce by proclamation the use of brick and stone, in the building of London, which had previously been of wood?

Because he might prevent the too rapid consumption of our native forests, as well as ensure greater security against fire.

Why, in old English houses, did the stories jut one over the other, so as almost to arch across narrow streets?

Because their frame-work was of timber, and the wooden foundations might thus be kept dry, at a time when no other mode was employed for conveying away the rain-water from roofs, than in the dropping eaves, or dragon-mouth spout.

Why may the artisan now be said to enjoy luxuries in domestic furniture, which were, but three centuries ago, beyond the reach of the crowned head?

Because heavy tables, formed of planks laid upon tressles, massy oak benches or stools for seats, and floors strewed with straw, formed the accommodation which satisfied the princes and prelates of our early history. Even in the time of Elizabeth, the comfort of a carpet was seldom felt, and the luxury of a fork wholly unknown. Rushes commonly supplied the place of the former, and the fingers were the invariable substitutes for the latter.

Harrison, writing in the time of Elizabeth, thus describes the furniture in use immediately before his time:—"Our fathers (yea, we ourselves also) have lien full oft vpon straw pallets, or rough mats, covered

onlie with a sheete, vnder coverlets made of dogswain or hopharlots, (I use their own term) and a good round log under their heads instead of a bolster or pillow. If it were so that our fathers or the good man of the house, had, within seven yeares after his marriage, purchased a mattrasse or flockebed, and thereto a sacke of chaff to rest his head upon, he thought himself to be as well lodged as the lord of the towne, that, peradventure, lay seldom in a bed of down or whole feathers. As for servants, if they had any sheet above them it was well; for seldom had they any under their bodies to keep them from the pricking strawes that ran oft through the canvas of the pallet, and rased their hardened hides."

Why was the hair of the goat one of the earliest articles employed in clothing?

Because, when mixed up with the short and soft fur of other animals, and united with the gum of trees and animal glue, it became that coarse but solid felt, known in Northern Asia from the earliest ages, and noticed by historians and poets. It was probably of this material that the black war-tunics of the Cimbri were made, in their conflicts with Marius; and we know it was the winter dress of the auxiliary cohorts, and even of the Roman Legions in Britain, at least to the era of Constantine.

Why is plaid so called?

Because it was originally composed of ribbon plait.

Why were plaid or check dresses common to most nations of northern latitudes during their state of incipient civilisation?

Because, possessing a knowledge of the distaff, they obtained the thread, which they platted into ribbons, and these they again platted into broader and warmer pieces; the stripes almost universal in the south were the same plats sewed together. That goat's hair was the chief ingredient among the Scandinavians, is

proved by their divinities being dressed in the goat's kirtle.

Why were the goat and sheep held sacred among the early nations?

Because the wandering shepherd guided his nightly course by the stars; he observed the connexion of the seasons by the passage of the sun through certain parts of the heavens; he named the stars within this range after the objects most familiar to his mind, and his zodiac was thus formed with *Capricorn* and *Aries* among its members or houses. These names, at first applied for the purpose of divisional designation, as they stood connected with real or supposed duties, or events relating to pastoral life, gradually acquired the character of sacred; and the same minds which had selected them from common objects, by no uncommon transition, typified them with characteristic attributes, and then regarded their representatives as objects of veneration, of hope, or of fear. Among the Greeks, the goat and sheep were held sacred to one or more divinities, and sacrificed at their altars. In the Jewish law they were likewise sacrificed, but not with the same intention: for here the goat was expressly marked as emblematical of atonement, and in the Christian dispensation, the beautiful image of exalted innocence bearing the sins of mankind, is still retained in the figurative designation of the lamb.—*Cuvier.*

Why is the British name of Stonehenge, Choir-gaur, or the Giant's Dance?

Because it was fabled to have been built by giants, or otherwise constructed by magic art. Volumes have been written upon this venerable wreck of time, but Stonehenge may briefly be described as one of the temples in which the Britons worshipped their deities; composed of large rough stones disposed in a circle; for they had not sufficient skill to execute any finished edifices. The huge masses of rock may still be seen

near Salisbury, gray with age, and the structure is yet sufficiently perfect to enable us to understand how the whole pile was anciently arranged. These masses are so large, that they seem to have been raised by more than human power, and thus to favour the above tradition.

RELIGION AND EDUCATION.

Why was the establishment of Christianity in Britain of the greatest temporal as well as spiritual advantage to the community?

Because a large proportion of the population consisted either of slaves or of churls or villains, who were compelled to till the ground for the benefit of their masters. These classes immediately gained the comfort of rest, one day in seven. So strictly did the temporal laws protect the observance of the seventh day, the right and privilege of the poor, that the master who compelled his slave to work on the Sunday, was deprived of the means of abusing his power—the slave obtained his freedom.

Why were not poors' rates requisite before the Reformation?

Because, in the quaint language of Aubrey, "the charitable doles given at religious houses, and church ale in every parish, did the business. In every parish there was a church-house, to which belonged spits, pots, crocks, &c. for dressing provisions. Here the housekeepers met, and were merry, and gave their charity. The young people came there too, and had dancing, bowling, shooting at butts, &c. Mr. A. Wood assures me there were few or no alms-houses before the time of King Henry VIII; that at Oxford, opposite to Christchurch, is one of the most ancient in England. In every church was a poor man's box, and the like at great inns.

"There were very few free schools in England before the Reformation. Youth were generally taught

Latin in the Monasteries, and young women had their education, not at Hackney, as now, scilicet, anno 1678, but at nunneries, where they learnt needle-work, confectionary, surgery, physic, (apothecaries and surgeons being at that time very rare) writing, drawing, &c. Old Jackquar, now living, has often seen, from his house, the nuns of St. Mary, Kingston in Wilts, coming forth into the Nymph Hay, with their rocks and wheels, to spin, sometimes to the number of threescore and ten, all of whom were young girls sent there for education."

Why was the Abbey "close" so called?

Because of its origin from *clausum*, shut or enclosed. Dr. Whitaker describes a close as an area of from fifty to ninety acres, enclosed by a high and sometimes embattled wall, and entered by one or two gateways. It included all the appendages of a large domain, as a grange, or farm-house, barns, stables, mill, &c. Around the principal quadrangle were disposed the church and its appendages, the hall, refectory, almonry, chapter-house, locutory or parlour, infirmary, scriptorium, kitchen, and other domestic offices. This great mass of irregular but stately buildings, when all standing, must have appeared like a small fortified town, with its embattled wall and turreted gate, surmounted by the great church, shooting high above the roofs.

Why was a bakehouse formerly attached to churches?

Because the clergy were charged to bake the oblation (i. e. the bread in the eucharist) *themselves*, or their servants *in their presence*. In old times, tenants were compelled to bake at the lord's oven, as they were to grind corn at his mill. This custom of baking still continues at Daventry, Northamptonshire.

Why are the edicts of the Pope called Bulls?

Because the seals appended to them were formerly of gold Bullion. The bull of Pope Clement VII, conferring the title of *Defender of the Faith* on Henry VIII, had such a seal of gold affixed to it.

Why are members of Universities said to be matriculated?

Because they are then entered in the *Matricula*, list, or register of admission.

Why is there so much unappropriated room in our Cathedrals?

Because in the Catholic times when they were erected, such room was appropriated to cross-carrying, canopy-carrying, censing, flower-strewing, and all the other accessories of the grand pageantry, which distinguished Catholic from Protestant worship.

Why is part of a church called a chancel?

Because formerly it was parted from the body of the church by *cancellæ*, or lattice-work.

Why are some church towers called campanile?

Because they contain the *campana* (Lat.) or bell.

Why were vanes on steeples so frequently made in the form of cocks?

Because of their appropriateness, in papal times, to remind the clergy of watchfulness; the tail of the cock, being conveniently shaped to catch the wind, was used as the face of the vane.

Why are some churches of a circular form?

Because they were built by affluent crusaders in imitation of that of the Holy Sepulchre, at Jerusalem. There are four examples almost in perfect preservation: The church of St. Mary, Temple, London, lately renovated; St. Sepulchre, Northampton; St. Mary, Cambridge; and that of Little Maplestead, Essex.

Circular temples are generally supposed to have been built with astronomical reference, especially the noble temple at Stonehenge. They existed among the Israelites. In Exodus, xxiv. 4, it is written that "Moses rose up early in the morning, and builded an altar under the hill, and twelve pillars." Again, in Joshua, iv. 9, "Joshua set up twelve stones;" and it is worthy of remark, that the twelve pillars of Moses

and Joshua, corresponded with the number of stones of the inner circles at Abury.

Why is part of the Church of England service called the Litany?

Because of its origin from the Greek for supplication; the Litany being a form of suplicatory prayer.

Why, in the Church of England Catechism, is the question, What is your name? answered N or M?

Because ecclesiastical forms ran, *Ego N. Episcopus Cov. et Lich.* and *Ego N. Decanus Eccl. Lich.* where N. means *Nomen*, intimating that the name is to be there inserted.—*Pegge's Anonymniana.*

Why is chanting part of the Cathedral service?

Because such was the practice of the churches in the earliest ages of Chistianity, and was no doubt derived from the usages of the Jewish ritual. In the reign of Theodosius, towards the end of the fourth century, St. Ambrose, Bishop of Milan, introduced into the churches of that place the Ambrosian chant, in order to rectify the practice of ecclesiastical chanting, which was then falling into great confusion; and St. Augustine, when speaking of his first entrance into the church there, after his conversion, says, "the voices flowed in at my ears, truth was distilled in my heart, and the affection of piety overflowed in sweet *tears* of joy." That sublime composition, the *Te Deum*, is generally attributed to St. Ambrose, though the Benedictine editors of his works do not describe it as his; whilst by Cave and Stillingfleet it is said to have been composed by him in conjunction with St. Augustine; and Usher ascribes it to Nicentius. The method of singing and chanting was, according to St. Eusebius, first established by St. Ambrose at Antioch, where he had long resided.

Why do some persons turn their faces eastward at the repetition of the creed?

Because of the ancient practice of the church

worshipping towards the East. This, says Bourne, they did, that by so worshipping they might lift up their minds to God, who is called the Light, and the Creator of Light; therefore turning, says St. Austin, our faces to the East, from whence the day springs, that we might be reminded of turning to a more excellent nature, namely, the Lord. As also, that as man was driven out of Paradise, which is towards the East, he ought to look that way, which is an emblem of his desire to return thither. Again, it was used when they were baptized: they first turned their faces to the West, and so renounced the Devil, and then to the East, and made their covenant with Christ. Lastly, those of the ancient church prayed that way, believing that our Saviour would come to judgment from that quarter of the heavens, St. Damascen asserting that when he ascended into Heaven, he was taken up eastward, and that his disciples worshipped in that way; and therefore chiefly it was, that in the ancient church they prayed with their faces to the East.

Selden likewise says, "'t is in the main allowed that the Heathens did, in general, look towards the East, when they prayed, even from the earliest ages of the world." The Rev. Mr. White, in his *History of Selborne*, in speaking of the church, says; "I have all along talked of the East and West end, as if the chancel stood exactly true to those points of the compass; but this is by no means the case, for the fabric bears so much to the north of the east, that the four corners of the tower, and not the four sides, stand to the four Cardinal points. The best method of accounting for this deviation, seems to be, that the workmen, who probably were employed in the longest days, endeavored to set the chancels to the rising of the Sun."

Why are altars of the highest antiquity?

Because of their early mention in Holy Writ, where it is said, that "Noah built an altar to the Lord."

Why were altars in the patriarchal times generally of single blocks of stone?

Because large, massive, unhewn stones, were considered to be emblematic of dignity and power. The indefatigable Mr. Britton, in his *Architectural Dictionary*, says: "In the Celtic, or Druidical temples, there were altars; and it is generally agreed, that a flat stone, near the western part of the interior area of Stonehenge, was used for that purpose. Cromlechs are considered to have been used as altars, by some antiquaries." In the early ages, altars were made of wood, and were mostly small, plain, and portable; but, on the establishment of Christianity under Constantine, stone was used. Erasmus mentions a wooden altar as remaining in his time at Canterbury Cathedral; and Batteley enumerates thirty-seven altars here prior to the Reformation. In parish-churches also, were altars dedicated to different saints; that of Lambeth, in Surrey, had five besides the high altar. Bequests were often made to provide candlesticks, sconces, lamps, and oil, for the different altars; and, in some parts of the country, a tax, called *Leot-shot*, was levied to furnish wax for the same purpose.

Why is the communion-table also called the altar?

Because plain communion-tables were substituted for altars in parish churches, on the accession of Queen Elizabeth. Numerous entries in the churchwardens' books, prove a strict compliance with the queen's order. Thus, in those of St. Helen's, Abingdon, Berks, are these items: "An. 1559. For taking down the altere, 20*d.*"—"An. 1560. Payde for tymber and making the communion-table, 6*s.* For a carpet for the communion-table, 2*s.* 8*d.* For paving the place where the altere stood, 2*s.* 8*d.*"

Why is Ave-Maria Lane so called?

Because, in Popish times, text-writers and beadmakers dwelt there.

Why is Paternoster Row so called?

Because the stationers or text-writers dwelt there, who wrote and sold all sorts of books then in use, viz. A, B, C,—with the Paternoster, Ave, Creed, Graces, &c. The bead-turners were also called Paternoster-makers.

Why is Clerkenwell so called?

Because, around a well here, the parish-*clerks* of London assembled in former times, to perform sacred plays.

Why is the + used as a mark?

Because Withered, king of Kent, first adopted the sign of the cross for his mark to his grants, he being incapable to write his name. The majority of the barons who signed Magna Charta, made their marks, being ignorant of the science of writing.

Why was learning in the seventeenth century but little conducive to domestic enjoyment?

Because education then enjoined pedantic manners, greatly to the exclusion of ease and enjoyment: learning was then, as Aubrey describes it, downright pedantry.

A picture of the means of education, by the same writer, in 1678, is worthy of quotation:—"The conversation and habits of those times, were as starcht as their bands and square beards, and gravity was then taken for wisdom. The doctors in those days were but old boys, when quibbles passed for wit, even in their sermons. The gentry and citizens had but little learning of any kind, and their way of breeding up their children was suitable to the rest. They were as severe to their children as their schoolmasters,—and their schoolmasters as masters of the house of correction: the child perfectly loathed the sight of his parents, as the slave his torture. Gentlemen, of thirty and forty years old, were to stand like mutes and fools bare-headed before their parents; and the daughters (grown women) were to stand at the cup-board side during the

whole time of their proud mother's visit, unless (as the fashion was) leave was desired forsooth that a cushion should be given them to kneel upon, brought them by the serving-man, after they had done sufficient penance in standing. The boys (I mean the young fellows) had their foreheads turned up and stiffened with spittle; they were to stand mannerly forsooth, thus, their foretop ordered as before, with one hand at the bandstring, and the other behind. The gentlewomen had prodigious fans, as is to be seen in old pictures, like that instrument which is used to drive feathers, and in it had a handle, at least half a yard long; with these the daughters were oftentimes corrected, (Sir Edward Coke, Lord Chief Justice, rode the circuit with such a fan; Sir William Dugdale told me he was an eyewitness of it. The Earl of Manchester also used such a fan;) but fathers and mothers slasht their daughters in the time of their besom discipline, when they were perfect women. At Oxford, (and I believe at Cambridge) the rod was frequently used by the tutors and deans; and Dr, Potter, of Trinity College, I knew right well, whipt his pupil with his sword by his side, when he came to take his leave of him to go to the inns of court."

Why is it said that swearing "came in at the head, but it is going out at the tail?"

Because, at first, it prevailed among the nobility and gentry; whereas, it is now chiefly heard among the lower classes.

Why are the low vulgar called groundlings?

Because of their resemblance to a groundling, or fish which keeps at the bottom of the water.

BELLS.

Why was the curfew-bell so called?

Because it was rung by a law of William the Norman, at eight o'clock at night, that all persons should

then cover their lights and fires, (*couvre feu*) and go to bed. The practice of this custom, to its full extent, we are told, was observed only during that and the following reign. Thus, the curfew is supposed to be of Norman origin; but Henry maintains that it was, at that period, used in different parts of Europe, as a precaution against fires, then frequent and fatal from so many houses being built of wood. Peshall, in his *History of Oxford*, refers the curfew to an order of King Alfred. The only representation of the curfew, in shape, resembles a Dutch oven, and is said to have been of copper, ten inches high, sixteen inches wide, and nine inches deep; the ashes were raked in a heap to the back of the chimney, against which was placed the open part of the curfew, thus nearly excluding the air, and extinguishing the fire. Dr. Pegge, the antiquarian, conjectures the curfew to have been also a contrivance for baking bread, &c. as well as a covering for the fire. We may here mention, that Dutch ovens are of classical antiquity; and the resemblance between them and the curfew is against the conclusion of its Norman origin. The ascribed imposition of the curfew custom, as a specimen of the Conqueror's rigid sway, therefore, merits but little credence. Thomson has thus described this supposed act of tyranny:

> The shiv'ring wretches, at the Curfew sound,
> Dejected sunk into their sordid beds,
> And, through the mournful gleam of better times,
> Mus'd sad, or dreamt of better.

Gray's elegiac mention of the curfew, is as familiar as "household words."

Why are bells tolled in some London parishes at eight o'clock?

Because such was the hour at which the curfew was generally rung; though it must be added, that the above custom has, in most instances, been settled by the special legacy of some wealthy parishioner.

Why were Canterbury bells so called?

Because they were carried by pilgrims for their solace, and the pilgrimage to Canterbury was the most common.

Why were bells baptized?

Because, thus blessed, they were endowed with great powers, allaying, on being rung, all storms, driving away evil spirits, &c. Thus, the bell belonging to the church of Holywell, was christened in honour of St. Winifrede. On the ceremony, all the gossips laid hold of the rope, bestowing a name on the bell; and the priest, sprinkling it with holy water, baptized it in the name of the Father, &c.—*Pennant.*

The ascribed uses of bells are thus set forth in some monkish lines, translated by Fuller:

Funera plango . .	Men's deaths I tell By doleful knell.
Fulgora frango . .	Lightning and thunder I break asunder.
Sabbata pango . .	On Sabbath all To church I call.
Excito lentos . . .	The sleepy head I raise from bed.
Dissipo ventos . .	The winds so fierce I do disperse.
Paco cruentos . .	Men's cruel rage I do assuage.

"Laudo Deum, verum, plebem voco, congrego clerum, defunctos plero, pestem fugo, festa decoro."

Why was the appellation of "Tom" applied to so many large bells?

Because they were baptized "Thomas," in honour of that "Saint Traitor," (as Fuller styles him) Thomas à Becket. Thus, Tom of Lincoln, and Great Tom, "the mighty Tom," of Christchurch, Oxford.

Why, in the colleges at Oxford, does the Bible-Clerk knock at every room-door with a key, to waken the students in the morning, before he rings the chapel-bell?

Because it is a vestige of an ancient custom before the invention of bells, for convening religious assemblies

in monasteries: it was, by going by turns to every one's cell, and, with the knock of a hammer, calling the monks to church. This instrument was called, the Night Signal and the Wakening Mallet.—*Bingham.*

Why are there distinct knells, before the regular tolling of the bell, to denote whether it be for a man, woman, or child?

Because it originated in the custom in ringing the passing bell, for which we have substituted tolling the bell after death. Thus, Durand, who lived in the twelfth century, tells us, "that bells must be tolled twice for a woman, and thrice for a man; if for a clergyman, as many times as he had orders; and, at the conclusion, a peal on all the bells, to distinguish the quality of the person for whom the people are to put up their prayers. A bell, too, must be rung while the corpse is conducted to church, and during the bringing it out of church to the grave." Mr. Brand says, "this seems to account for a custom still preserved in the North of England, of making numeral distinctions at the conclusion of this ceremony; *i. e.* nine knells for a man, six for a woman, and three for a child, which are undoubtedly the vestiges of this ancient injunction of Popery."

Why was there originally a high price for tolling the largest bell of the church?

Because, exclusive of the additional labour, superstition ascribed to its louder sound the property of scaring evil spirits further off, to be clear of its knell, by which the poor soul got so much more the start of them. Besides, being heard further off, it would likewise procure the dying man a greater number of prayers. This dislike of spirits to bells is mentioned in the Golden Legend, by Wynkyn de Worde.—*Grose.*

In our times, great bells denote great age or rank. The *great bell* of St. Paul's, in London, is never tolled, except at the deaths and funerals of members of the

Royal Family, or of the bishops and lord mayors of London. It weighs four tons and a quarter, and has inscribed on it, "Richard Phelps made me, 1716." On similar occasions too, the bells are rung muffled, or in "dead peals;" as also on the death and funeral of a bell-ringer.

Why are clocks supposed to have been so called from the bells in them?

Because, in a passage of Bede, in King Alfred's Saxon version, in rendering *campana*, he has used *cluggan*, which properly signifies a clock. Clock is the old German name for a bell; and hence, it is called in French, *une cloche*. There were no clocks in England in Alfred's time; he is said to have measured his time by wax candles, marked with circular lines, to distinguish the hours.—*Ellis's Notes to Brand.*

Shakspeare has a pathetic mention of the bell of a clock in the soliloquy of the melancholy Richard II, in the dungeon of Pomfret castle:—

> The sounds that tell what hour it is,
> Are clamorous groans, that strike upon my heart,
> *Which is the bell.*

Why are bells rung on occasions of rejoicings?

Because, in times of Popery, this mark of respect was paid to emperors, bishops, and abbots, at places under their own jurisdiction; whence we seem to have derived the modern compliment of welcoming persons of consequence by a cheerful peal.

The parts of a bell are, the body, or carrel, the clapper within, and the ear, or cannon, without, whereby it is hung to a large beam of wood. Its usual material is a compound of iron and brass, called bell-metal. The thickness of a bell's edge is commonly one-fifteenth of the diameter of the bottom, and its height twelve times its thickness. The bell-founders or makers have a diapason or scale, by which they regulate the size, thickness, weight, and tone of the bells; and it may be remarked, that their sounds may be heard further in

plain or flat countries, than in hilly places, still further in valleys than in plains.—*Britton.**

"Bells," says Mr. Coleridge, "are the poor man's only music;" and in the ages of Merry England, the festivals of her calendar were welcomed with joyous peals in every parish. In short, to bells we may ascribe nearly all the effects attributed by Sir William Temple to the power of music:—"To raise joy and grief, to give pleasure and pain, to give motions to the feet as well as to the heart, to compose disturbed thoughts, and to assist and heighten devotion itself." Quoting Marvell's phrase for music too, they are "the mosaic of the air."

Why was the Passing Bell so called?

Because it was tolled for a person who was dying, that is, *passing* from life to death. In the "Advertisements for due Order, &c." 7th year of Queen Elizabeth, we find—"Item, that when a Christian bodie is *in passing*, that the bell be tolled, and that the curate be speciallie called for to comforte the sicke person; and after the time of his passinge, to ring no more but one shorte peale; and one before the buriall, and another shorte peale after the buriall." Shakspeare alludes to this custom:—

And his tongue
Sounds ever as a sullen bell
Remember'd knolling a departed friend.
Henry IV. Part 2.

Mr. Douce thinks the Passing-Bell was originally intended to drive away any demon that might seek to take possession of the *soul* of the deceased, on which account it was sometimes called the *Soul-Bell.* We need scarcely add, this must have been one of the utmost extravagances of Popery; but old engravings of devils waiting in the chamber of the dying man to whom the priest is administering extreme unction—warrant the above inference. Mr. Ellis, in his notes

* In South America, bells are not unfrequently made of silver.

to Brand, quotes Wheatley's apology for our retaining this ceremony: "Our Church," says he, "in imitation of the saints in former ages, calls on the minister, and others who are at hand, to assist their brother in his last extremity. In order to this, she directs, that when any one is passing out of this life, a bell should be tolled," &c. Hence the proverb mentioned by Bede:—

When the bell begins to toll,
Lord have mercy on the soul:—

and the following couplet, to be found in Ray:—

When thou dost hear a toll or knell,
Then think upon thy *passing bell.*

Dr. Zouch considers the passing-bell to have been the origin of praying for the dead.

Pennant enumerates the mode of ringing this bell: "The canon allows one short peal after death, one before the funeral, and one other after the funeral. The second is still in use, and is a single bell solemnly tolled. The third is a merry peal, rung at the request of the relations; as if, Scythian-like they rejoiced at the escape of the departed out of this troublesome world."

Why is St. Sepulchre's Bell tolled on the eve before and during the execution of criminals at Newgate?

Because a legacy was bequeathed to that parish, on condition, that "after the several Sessions of London, when the prisoners remain in the gaole as condemned men to death, expecting execution on the morning following; the clarke (that is, the parson) of the church should come in the night time, and likewise in the morning, to the window of the prison where they lye, and there ringing certain tolls with a hand-bell, he doth put them in mind of their present condition, &c." He was likewise to toll the same bell, and pray with the criminals in the cart in the morning. The person by whom this legacy (£50.) was left, was a merchant-tailor, and the beadle of his company was to see that the conditions of the bequest were complied with. The

duty has, however, been transferred from the clergyman to the bellman, it being a very ancient custom for the latter, on the night previous to an execution, to go under Newgate, and having rung his bell, repeat these verses, as a friendly admonition to the wretched prisoners:—

All you that in the condemned hold do lie,
Prepare you, for tomorrow you shall die!
Watch all, and pray, the hour is drawing near,
That you before th' Almighty must appear.
Examine well yourselves, in time repent,
That you may not t' eternal flames be sent.
And when St. Sepulchre's bell tomorrow tolls,
The Lord above have mercy on your souls!
Past Twelve o'Clock!

We learn this from Stowe, and an old work, the *Annals of Newgate.* The whole ceremony is, however, now commuted to the evening and morning tolling of the bell.

Why were bells formerly rung during thunder-storms?

Because they were believed to make the storm cease, and "purifie the aire." Aubrey says, "when it thundered and lightened, they did ring St. Adelin's bell, at Malmesbury Abbey."*

DEATHS.

Why is watching with the dead called, in the north of England, the Lake Wake?

Because it is plainly derived from the Anglo-Saxon Lic or Lice, a corpse, and Wacce, a wake, vigil, or watching. This consists of sitting by the corpse from the time of death till its exportation to the grave, either in the house, or in the church itself. In Scotland, they are called Like Wakes, which ancient custom, Dr.

* Akin to the superstitious reverence once attached to bells in England, may be mentioned the *oracion* in Spain, which sounds at sunset, when every one, as if by magic, seems fixed in his place, uncovers the head, and repeats, or is supposed to repeat, a mental prayer for a few minutes. At theatres, &c. the sound of this bell suspends the entertainments till the prayer is said; and so great is its effect, that it is said that assassins, at the moment of executing their horrid design, have held their hand at the sound of the *oracion*, and after repeating the habitual prayer, have perpetrated their diabolical purpose.—*Jacob's Travels.*

Jamieson says, "most probably originated from a silly superstition with respect to the danger of a corpse being carried off by some of the agents of the invisible world, or exposed to the ominous liberties of brute animals. But, in itself, it is certainly a decent and proper one; because of the possibility of the person considered as dead being only in a swoon." In Wales a similar ceremony is performed, with an illumination by candles. An Irish wake has been best described by the graphic pen of Miss Edgworth: "At night the body is waked; that is to say, all the friends and neighbours of the deceased collect in a barn or stable, where the corpse is laid upon some boards, or an unhinged door, supported upon stools, the face exposed, the rest of the body covered with a white sheet. Round the body are stuck, in brass candlesticks, which have been borrowed perhaps at five miles distance, as many candles as the poor person can beg or borrow, observing always to have an odd number. Pipes and tobacco are first distributed, and then, according to the ability of the deceased, cakes and ale, and sometimes whisky, are *dealt* to the company. After a fit of universal sorrow, and the comfort of an universal dram," a very lively scene ensues. Indeed, Miss Edgworth tells us "it is said that more matches are made at wakes than at weddings," which reminds one of Swift's note of the merriest faces being often seen in mourning coaches. Wakes among the Irish poor are by no means uncommon in London, where they soon pass from grave to gay. The candles are of the finer description, called moulds, and they have similar enlightenments at Easter, Christmas, &c.

Why were the cats of the house locked up, as soon as any person died therein?

Because they might be kept from making any depredations upon the corpse, which it is known they would do, if not prevented.—*Ellis's Notes to Brand.*

All the looking-glasses were likewise locked up on this

occasion. This is also common in France, and is thus explained by a French antiquary: "The individual has disappeared; he is carried to the bosom of the great family; he will not appear again on earth. Thus, his portrait, the glasses which represent only his mortal remains, become useless, when the soul which animated them is no longer among us. For the same reason that the glasses are veiled, many persons, particularly the Jews, empty all the water from the vessels in the house; and the country people in France assign as a motive for doing so, that they are afraid the soul, in departing from the body, will be drowned while washing itself in the water! The pendulums of clocks are also taken off, or stopped, because the last hour has sounded, time no longer exists for him who has been struck by the hand of death; he enters into eternity, and for him the hours cease to be marked!"

Why are "corpse candles" so called in Wales?

Because they are lights superstitiously said to veer towards the church-yard, which they enter, hover round the spot where the person whose death they intimate will be buried, and disappear. They vary in brilliancy and size, according to the person whose doom it is to leave the world: thus, an infant's would not be larger than the flame of a common candle, whilst a man's is proportionally larger. The colour is said to be a sulphureous blue, or red, and when any one observes them approach, if he does not move aside, he will be struck down by their force. If they are seen to stop, the corpse will do the same at the funeral; if they move aside, it will occur so at the burial; and, should two candles meet, the two funerals will do the same: it is also said, that if a person looks back at one after it has passed him, he will perceive the corpse and its attendants. It may be requisite to add, that these superstitious notions are actually current to this day in Wales, as we learn from a collection of *Cambrian Superstitions* published

but a few months since. The author says these lights must not be confounded with the Will o' the Wisp, and attributes their appearance to "a bishop of St. David's, a martyr, who, in olden days, whilst burning, prayed that they might be seen in Wales (some say in his diocese only) before a person's death, that they might testify he had died a martyr; and in many parts of North Wales, the people are almost distracted when they see them, as it is not known whose death they predict."

Why, on the decease of any wealthy person, were the friends and neighbours invited to dinner on the day of interment?

Because, originally a solemn festival was made at the time of publicly exposing the corpse, to exculpate the heir, and those entitled to the possessions of the deceased, from fines and mulcts to the lord of the manor, and from all accusation of having used violence; so that the persons then convoked, might avouch that the person died fairly, and without suffering any personal injury. The dead were thus exhibited by ancient nations, and perhaps the custom was introduced here by the Romans.—*Hutchinson's History of Northumberland.*

Feasting seems to have been a general accompaniment or supplement to a funeral. In Strype's edition of Stowe's *London*, we read from a parish register, that one "Margaret Atkinson, widow, by her will, October 18, 1544, orders, that the next Sunday after her burial there be provided two dozen of bread, a kilderkin of ale, two gammons of bacon, three shoulders of mutton, and two couples of rabbits; desiring all the parish, as well rich as poor, to take part thereof; and a table to be set in the midst of the church, &c." And in the minute-book of the Antiquarian Society, 1725, we read, in an account of a Highland Lord's funeral, "after the body is interred, a hundred black cattle, and two or

three hundred sheep, are killed, for the entertainment of the company."

Why did the heathens follow the corpse to the grave?

Because it presented to them what would shortly follow, how they themselves should be so carried out, to be deposited in the ground. Christians observe the custom for the very same reason; and, as this form of procession is an emblem of our dying shortly after our friend, so the carrying of ivy in our hands, sprigs of laurel, rosemary, or other evergreens, is an emblem of the soul's immortality.

Of these plants, rosemary was most common; and the pastoral poets frequently refer to its use. Gay, in a dirge, says—

> To shew their love, the neighbours, far and near,
> Followed, with wistful look, the damsel's bier:
> Sprigg'd rosemary the lads and lasses bore,
> While dismally the parson walk'd before.

An old dramatist, Cartwright says—

> Pr'ythee see, they have
> A sprig of rosemary, dipp'd in common water,
> To smell at as they walk along the streets.

Misson, in his *Travels*, says, when the funeral procession is ready to set out, "a servant presents the company with sprigs of rosemary; every one takes a sprig, and carries it in his hand till the body is put into the grave, at which time they all throw in their sprigs after it." In Shirley's *Wedding*, yew, bays, and rosemary, are thus mentioned:—

> *Beauford.*—Are these the herbs you strow at funerals?
> *Servant.*—Yes, Sir.
> *Beauford.*—Ha' ye not art enough
> To make this yew-tree grow here, or this bayes,
> The emblems of our victory in death?
> But they present that best when they are wither'd.

Why are so many stone coffins found in this kingdom?

Because it is supposed that formerly all persons of rank and fortune were buried in that manner.—*Gent. Mag.*

The Sarcophagus, which is a Greek word, but adopt-

ed by the Latins, and signifies a coffin or grave, has its name from a certain property which the stone is said to have had, of consuming the dead body in a few days.—*Pliny, Nat. Hist.*

Why are spears, shields, &c. sometimes found in the burial-places of ancient heroes?

Because it was customary to bury these martial instruments with the owners, if the hero was the last of the family; otherwise, their armour was bequeathed to their sons, to be kept in the hall from generation to generation.

Again, it was probably believed, that the dead delighted in those things which had pleased them when they were alive, and that the disembodied spirit retained the inclinations and affections of mortality.—*Palgrave.*

Why was the practice of burning the dead, general in ancient Greece?

Because Heraclitus taught that fire was the predominant principle in the human fabric; and that, therefore, by the reduction of the body to its first principles, their purity and incorruptibility were better preserved. Another opinion was, that by burning the body, all rage and malice, the general issues of hatred and enmity, which often surround their object, were checked and prevented.

Sir Thomas Brown concludes a very learned dissertation upon the funeral customs of the Greeks, the Romans, the Egyptians, the Jews, the Danes, &c. in favour of *cremation*, or burning; "for," says he, "to be knaved out of our graves, to have our skulls made drinking bowls, and our bones turned into pipes, to delight and sport our enemies, are tragical abominations escaped in burning burials." This species of interment is called *Urn Burial*, from the ashes being collected, and placed in a votive urn. The hearts of royal and noble persons are, in these times, preserved

and buried in urns: that of Lord Byron was thus conveyed to England, and placed upon his coffin in the vault.

Why has burying in churches become so general?

Because persons of reputed sanctity were first placed there: founders and patrons, and other great names began to creep as near as they could to the fabric, and so were laid in the porch, or in the entry of the cloisters, or in the cloister itself, before the chapter-house door, or in the chapter-house, or in the sacristy. Sometimes the bodies were deposited in the wall, first on the outside, and then in the inside, of the wall. In process of time, they began to erect aisles, and to bury and establish chantries in them; after which, they made free with the body of the church; and lastly, but chiefly since the Reformation, except in the cases of sanctity above-mentioned, they had recourse to the chancel.—*Gent. Mag.*

Why have hour-glasses been found in coffins with the dead?

Because it was an ancient custom to put an hour-glass into the coffin, as an emblem of the sand of life being run out: others conjecture, that little hour-glasses were anciently given at funerals, like rosemary, and by the friends of the dead put into the coffin, or thrown into the grave.

Why were some funeral garlands called "depository?"

Because they were carried solemnly before the corpse by two maids, and afterwards hung up in the church, in memorial of the deceased.

Why were garlands subsequently placed upon the coffin in the grave?

Because they were considered unbecoming decorations for the church, and were not allowed to be hung up there. This change was introduced with the last century.

Why is it customary in some places to sing psalms at funerals?

Because such was the practice in the primitive church. Mr. Gough quotes Macrobius, who assigns as a reason, that it implied the soul's return to the origin of harmony, or heaven.

Why is a burial also called a funeral?

Because of its origin from *Funus*, (Lat.) from *funes accensi*, or *funalia*, *funales cerei*, *cereæ faces*, *vel candelæ*, torches, candles, or tapers, originally made of small ropes or cords, (*funes vel funiculi*) covered with wax or tallow. We quote these roots to show, that all funerals among the Latins or Romans used to be performed by torchlight.

Why were persons formerly buried with the burning of torches?

Because it was very honourable; and to have a great many was a special mark of esteem in the person who made the funeral to the deceased. Thus, by the will of William de Montacute, Earl of Salisbury, executed April 29, 1398, twenty-four poor people, clothed in black gowns and red hoods, are ordered to attend the funeral, each carrying a lighted torch of eight pounds weight. After the service, it was customary for the relations to extinguish their flambeaux in the earth, with which the corpse was to be covered.

Dr. Pegge, commenting upon a record of this custom, date 1460, says: "Little was to be done in these ages of gross popery without light. These torches cost 1*s*. 8*d*. apiece; but we find them of various sizes and prices. The churchwardens appear to have provided them, and, consequently, they were an article of profit to the church. The torches, it is conceived, were made of wax; and, in ordinary cases, were let out by the church, and charged to the party, according to the consumption at the moment. This appears in the York churchwarden's accompts, where wax is charged."

Why at funerals, are wine and cake given among the rich, and ale among the poor?

Because an entertainment or supper made part of a funeral among the Greeks and Romans: Cicero calls it *Circumpotatio*, or drinking round.

Misson, in his *Travels in England*, under 'Funerals,' says: "Before they set out, and after they return, it is usual to present the guests either with red or white wine, boiled with sugar and cinnamon or some such liquor. Every one drinks two or three cups. Butler, the keeper of a tavern, (the *Crown and Sceptre*, in St. Martin's-street) told me that there was a tun of red Port wine drunk at his wife's burial, besides mulled white wine. Note—no men ever go to women's burials, nor the women to men's, so that there were none but women at the drinking of Butler's wine." Burnt Claret and diet bread were also used on these occasions.

Why are funeral entertainments considered of very old date?

Because Cecrops is said to have instituted them for the purpose of renewing decayed friendship among old friends, &c.

Why do the Irish howl at funerals?

Because the Romans formerly did so at the decease of their friends, they hoping thus to awaken the soul, which they supposed might lie inactive.

Why was it formerly customary to kill a cow at an Irish funeral?

Because of a Canon taken from an Irish Synod:—"Every dead body has in its own right, a cow, and a horse, and a garment, and the furniture of his bed: nor shall any of them be paid in satisfaction of his debts, because they are, as it were, peculiar to his body.

Why were yew-trees anciently planted in church-yards?

Because in times when it was considered important that the churches should, at certain seasons, be adorned with evergreens; and when, to strew branches in the way, and to scatter herbs and flowers into the graves, were practised as religious rites, it was "behovable and convenient for the service of the church," that every churchyard should contain at least one yew-tree. Several reasons may be assigned for giving this tree a preference to every other evergreen. It is very hardy, long-lived, and produces branches in abundance, so low as to be always within reach of the hand; and at last it affords a beautiful wood for furniture. It appears, that not only were trees, but also flowers formerly common in churchyards for ceremonies. Thus, in the will of King Henry VI, there is the following item: "the space between the wall of the church and the wall of the cloyster, shall conteyne 38 feete, whis left for to sett in certaine trees and flowers, behovable and convenient for the custom of the same church."

Mr. Brand and Mr. Ellis note nearly a dozen pages upon the planting of yew trees in churchyards; but neither of the reasons there adduced, appears to us more powerful than the fact of the yew being a consecrated tree in the ancient laws of Wales; wherefore, and by its natural sombre fitness, it would readily be admitted into our cemeteries. In these records,

"A consecrated yew, its value is a pound.
"A misletoe branch, threescore pence.
"An oak, sixscore pence.
"Principal branch of an oak, thirty pence.
"A yew-tree *(not consecrated)* fifteen pence."

Sir Thomas Brown conjectures, from its perpetual verdure, the yew was used as an emblem of the resurrection; and tells us, that "the ancient funeral pyre consisted of sweet fuell, cypresse, firre, larix, *yewe*, and trees perpetually verdant."

The uses and properties of the yew have been copiously illustrated by the poets. Virgil calls it the

baneful yew,—and Dryden, the *mourner yew*. Shakspeare has numerous allusions: "slips of yew," and "churchyard yew," occur in the mystical rites of *Macbeth*; and the custom of "sticking yew in the shroud," is mentioned in a song in *Twelfth Night*, thus:

Come away, come away, Death,
And in sad cypress let me be laid;
Fly away, fly away, breath;
I am slain by a fair cruel maid.
My shroud of white, stuck all with yew,
O prepare it;
My part of death, no one so true
Did share it.
Not a flower, not a flower sweet,
On my black coffin let there be strown.

Here Mr. Ellis reminds the reader, that in whatever country Shakspeare lays the scene of his drama, he follows the costume of his own. A credible person, who was born and brought up in a village in Suffolk, informed Mr. Ellis, in 1812, that when he was a boy, it was customary there to cut sprigs and boughs of yew-trees to strew on graves, &c.

We conclude with an exquisite Love Lament, from Beaumont and Fletcher's *Maid's Tragedy*.

Lay a garland on my hearse,
Of the dismal yew;
Maidens, willow branches bear:
Say I died true:
My love was false, but I was firm
From my hour of birth:
Upon my buried body lie
Lightly, gentle Earth.

Why has the yew been called "double fatal?" (*Shakspeare.*)

Because the leaves of the yew are poison, and the wood was employed for making instruments of death, as bows. (See *Sports and Pastimes*, p. 31: Part VI.)

Why was cypress used by the heathens?

Because, being once cut, cypress will never flourish nor grow again; and is thus an emblem of dying for ever; but instead of that, the ancient Christians used

other plants and deposited them under the corpse in the grave, to signify that they who die in Christ, do not cease to live; for, though as to the body, they die to the world, yet, as to their souls, they live and revive to God.—*Bourne.*

Why were the bodies of the ancients preserved by embalming?

Because they were kept with an antiseptic powder, composed of two parts of camphor, one of resin, one of nitre, and a sprinkling of rose-water and lavender.

Why is an embalmed body called a mummy?

Because of its origin from the Egyptian word *mum*, wax, which is used in embalming. The custom of embalming, originated in a vanity amongst the Egyptians of being considered immortal.

Why is a pompous tomb called a mausoleum?

Because the name was first given to a stately monument erected by his queen, Artemisia, to her husband, Mausolus, King of Caria.

Why in the primitive Christian Church were crowns of flowers placed at the head of deceased virgins?

Because virginity was honoured, out of deference, most likely to the Virgin-Mother, with almost divine adoration, and there is little doubt, but that the origin of Nunneries is closely connected with that of the Virgin garland.

These garlands or crowns, were most artificially wrought in fillagree work, with gold and silver wire, in resemblance of myrtle, with which plant the funebrial garlands of the ancients were always composed, whose leaves were fastened to hoops of larger iron wire, and they were lined with cloth of silver.—*Antiq. Repertory.*

The elegant pen of Miss Anna Seward informs us, date 1792, that the ancient custom of hanging a garland of roses made of writing-paper, and a pair of white gloves, over the pew of the unmarried villagers

who died in the flower of their age, prevailed to that day in the village of Eyam, (in Derbyshire) and in most other villages and little towns of the Peak. Gay thus alludes to these garlands:—

> To her sweet mem'ry flow'ry garlands strung,
> On her now empty seat aloft were hung.

Why was the selection of flowers, and the manner of arranging them into garlands a peculiar art among the ancients?

Because the females communicated their sentiments to their lovers by a garland, as the oriental nations of the present day communicate a love letter, in a bouquet. It was not only the colours, but also the colour of each flower, that governed this symbolical language.

Why were churchyards first used for interment?

Because of the superstitious dread of the living. Mr. Strutt tells us that before the time of Christianity, it was unlawful to bury the dead within the cities, but they used to carry them out into the fields, and there deposit them. Towards the end of the sixth century, Augustine obtained of King Ethelbert, a temple of idols, (where the king used to worship before his conversion) and made a burying-place of it; but St. Cuthbert afterwards obtained leave to have yards annexed to the churches, proper for the reception of the dead.*

Why was there formerly a superstitious objection to burial in the churchyard north of the church?

Because that quarter was believed to be appropriated for the interment of unbaptized infants, of

* A plan is now in progress for a public cemetry, in the neighbourhood of London, or "out in the fields," so that we are about to revert to a custom upwards of 1200 years old; though it should be added for very different reasons: our forefathers buried thus through fear, but the proposed change is on account of the crowded state of our churchyards, and a very proper consideration of the public health. We may add that public cemeteries have already been established at Liverpool and elsewhere.

persons excommunicated, and that have been executed, and of suicides. The Rev. Gilbert White, of Selborne, complains of the crowded state of the churchyard there: "at the east end are a few graves; yet none till very lately on the north side;" the south was generally preferred. In Ireland, the north was termed the wrong side of the church.

Why are flat stones laid over the graves in churches and churchyards?

Because that was the practice in very ancient times, as appears from the writings of Cicero and others. Mr. Gough tells us that "it is the custom at this day all over Wales to strew the graves, both within and without the church, with green herbs, branches of box, flowers, rushes, and flags, for one year; after which such as can afford it lay down a stone.

Why were graves originally fenced with osiers, &c.

Because they might be protected from beasts who were allowed to graze in the churchyard. Gay says:

> With wicker rods we fenc'd her tomb around,
> To ward from man and beast the hallow'd ground:
> Lest her new grave the parson's cattle raze,
> For both his horse and cow the churchyard graze.

FLOWERS—THE ROSE.

Why were flowers formerly strewed at village funerals?

Because such was a custom of the ancient church, and was observed among the heathens. Anchises grieving for Marcellus, makes him say:—

> Full canisters of fragrant lilies bring,
> Mix'd with the purple roses of the spring,
> Let me with fun'ral flowers his body strew,
> This gift which parents to their children owe,
> This unavailing gift, at least I may bestow.—*Virgil.*

In Wales, this custom of strewing the graves, as well as filling the bed, the coffin, and the room, is observed to this day. We remember witnessing the latter rite, at Hemel Hempstead, in Hertfordshire, in 1809, where a young boy dying at school, the body and the open coffin, as well as the room in which it

was placed, were decorated with flowers, and the school-fellows of the deceased, upwards of 100 in number, were admitted to view the mournful scene.

Of this custom there are many poetical notices.

Shakspeare, in *Romeo and Juliet*, makes Friar Laurence say:—

> Dry up your tears, and stick your rosemary
> On this fair corse.

Sir Thomas Overbury concludes his character of "the fair and the happy Milkmaid:" "Thus lived she, and all her care is that she may die in the spring-time, to have store of flowers stucke upon her windingsheet." Again, Shakspeare's Arviragus, in *Cymbeline*:—

> With fairest flowers,
> Whilst summer lasts, and I live here, Fidele,
> I 'll sweeten thy sad grave: thou shalt not lack
> The flower, that 's like thy face, pale primrose; nor
> The azur'd hare-bell, like thy veins; no, nor
> The leaf of eglantine, whom, not to slander,
> Outsweeten'd not thy breath.
> *   *   *   *   *
> Yea, and furr'd moss besides, when flowers are none,
> To winter-ground thy corse

And at Ophelia's interment in *Hamlet*, ("that piece of Shakspeare's which appears to have most affected English hearts,"*)

> Lay her i' the earth;—
> And from her fair and unpolluted flesh
> May violets spring.

The appropriateness of spring-flowers for this rite is also touched upon by Herrick:—

> Virgins promis'd when I died,
> That they would each primrose-tide,
> Duly morn and evening come,
> And with flowers dress my tomb:
> Having promis'd, pay your debts,
> Maids,—and here strew violets.

That excellent man, Jeremy Taylor, says, "Though I should like a dry death, yet I should not like a dry funeral. Some flowers strewed upon my grave would do well and comely; and a soft shower to turn these

* Shaftesbury.

flowers into a springing memory, or a fair rehearsal." The pious John Evelyn also says, "We adorn their graves with flowers and redolent plants, just emblems of the life of man, which has been compared in Holy Scriptures to those fading beauties, whose roots being buried in dishonour, rise again in glory."*

Why was the rose a favoured flower?

Because it is distinctly specified in the ancient rite; indeed, the Greeks and Romans often, in their wills, directed roses to be strewed and planted on their graves, as specified by an old inscription at Ravenna, and another at Milan. It is also alluded to by Propertius and Anacreon.

Lord Byron, to a letter from Bologna, dated June 7, 1819, makes the following postcript:—"Here, as in Greece, they strew flowers on the tombs: I saw a quantity of rose-leaves and entire roses scattered over the graves at Ferrara. It has the most pleasing effect you can imagine."

Rose-trees on graves were not rare in England. Camden, in his *Britannia*, says, at Ockley, in Surrey, a few miles from Dorking, "is a certain custom, observed time out of mind, of planting rose-trees on the graves, especially by the young men and maidens who have lost their loves: so that the churchyard is now full of them." Aubrey observes of the same place:—"in the churchyard are many red rose-trees, planted among the graves, which have been there beyond man's memory. The sweetheart (male or female) plants roses at the head of the grave of the lover deceased:

* We could extend these notices of *Flowers on Graves* to many pages, were we to indulge our full feelings on the subject. *Père la Chaise*, at Paris, is too well known to require description here; indeed, the rite is too artificially observed there. Among our miscellaneous notices we find that the Hainanes have a custom of visiting the tombs of their parents once a year, in order to pluck away the weeds and grass from their graves; and freshen with paints of different colours the characters of their epitaphs: this they consider an imperious duty, and accordingly perform the ceremony with much solemnity.

a maid that lost her dear twenty years since, yearly hath the grave new turfed, and continues yet unmarried." Evelyn, whose authority for this custom we have just quoted, lived at Wotton-place, about four miles distant from Ockley, and thus testifies its observance there. Of the rose he says, "this sweet flower, borne on a branch set with thorns, and accompanied with the lily, are natural hieroglyphics of our fugitive, umbratile, anxious, and transitory life, which, making so fair a show for a time, is yet not without thorns and crosses." At Ockley, he adds, "the maidens yearly planted and decked the graves of their defunct sweethearts with rose-bushes."—*See his Sylva.*

Within a few miles of London, that emporium of art, at Barnes, on the banks of the Thames, is an interesting observance of this rite. On the south wall of the church is a tablet, enclosed by pales, with rose-trees planted on each side of it. This tablet is to the memory of Edward *Rose*, citizen of London, who died in 1653, and left £20 to the poor of Barnes, for the purchase of an acre of land, on condition that the pales should be kept up, and the rose-trees preserved. What amiable eccentricity!

In Wales, we read, the white rose is always planted on a virgin's tomb: the red rose is appropriated to the grave of any one distinguished for benevolence of character.

Why are evergreens also planted on the graves?

Because they may supply the place of flowers which have been merely stuck in the ground at the time of the funeral, and which soon drooped, and perished. The churchyard of Britton Ferry has been long noted for the luxuriance of the evergreens which overshadow the tombstones.

Flowers, however, appear to have been the favourite tributes of joy and grief.

With what touching truth has it been said there is

Glory in the grass, and splendour in the flower,—

the emblematical employment of flowers in all ages of the world amply testify. Among the ancients, according to Pliny, flowers were used symbolical of spring; and upon many medals which represent this happy season of the year, by four children or genii, that of spring always carries a basket filled with flowers. Hope is also figured by the ancient artists and poets holding a flower in her hand. Venus is sometimes so represented, or crowned with a garland of flowers. Persons conveying good news crowned themselves also with flowers to indicate the happy tidings of which they were the bearers. They cast flowers in the paths of those whom they would honour, as we have shown to be still the custom on coronations, in marriages, and in lovers ornamenting with festoons and garlands the houses of their mistresses. They were also carried in the Floralia, as is our custom still on May Day. They crowned with flowers the victims which were led to sacrifice; and they decorated the tombs of their beloved and honoured kindred with flowers, which they renewed on the anniversary of their departure from this world, as is still the custom in Catholic countries. Flowers also among the ancients contributed to the joyousness of the banquet. The revellers wore chaplets or crowns of flowers upon their heads and round their necks; the perfumes of which were not only agreeable, but reckoned antidotes to infection.

Among the early christians, flowers were represented symbolically as representing gifts of the Holy Spirit. On this account it was, that at the feast of Pentecost or Whitsuntide, the priests cast flowers from the upper ambulatories of their churches, upon the congregation of the faithful assembled in the nave below; a custom which is still continued in Catholic countries, with the decoration of the churches, with flowers according to the season, which is observed also in many English Protestant churches. Flowers were also held by Ca-

tholics as symbolical of the delights of Paradise, and were accordingly figured upon the glasses of the early Christians; many representations of which are engraved in the works of Buonarotti.

Why was the fourth Sunday in Lent called Rose Sunday?

Because the Pope, on this day, carried a golden rose in his hand, which he exhibited on his way to and from mass.

Why was it usual with lovers to place a rose in the ear?

Because it implied, "Heare all and say nothing." —*Burton's Anatomy of Melancholy.*—At Kirtling, in Cambridgeshire, is a juvenile portrait of Queen Elizabeth, with a red rose sticking in her ear.

The rose, as an emblem of love and friendship, has been the queen-flower of lyric poets. Who can forget the *Last Rose of Summer*, by Moore; but mere especially the mournful minstrelsy of the last stanza:

> So soon may I follow,
> When friendships decay,
> And from love's shining circle
> The gems drop away!
> When true hearts lie withered,
> And fond ones are flown,
> Oh! who would inhabit
> This bleak world alone?

Why was it customary to gather a rose on Midsummer Eve?

Because it was superstitiously associated with the choice of a husband or wife. This custom, a relic of Druidical times, is thus mentioned in the *Connoisseur*, No. 50:—"Our maid Betty tells me, that if I go backwards, without speaking a word, into the garden upon Midsummer Eve, and gather a rose, and keep it in a clean sheet of paper, without looking at it till Christmas Day, it will be as fresh as in June; and if I then stick it in my bosom, he that is to be my husband will

come and take it out." We heard the condition differently related in our "careless childhood:" the rose was to be gathered and sealed up, while the clock struck twelve at mid-day.

LEASING.

Why is the custom of leasing or gleaning maintainable on the score of antiquity?

Because we know it has existed from the earliest periods,—three thousand years and upwards, for certain, as testified by Ruth, who gathered three pecks and over in a day.

Mr. Knapp, in the *Journal of a Naturalist*, says "if it were not then first instituted, it was secured and regulated by an especial ordinance of the Almighty to the Israelites in the wilderness, as a privilege to be fully enjoyed by the poor of the land, whenever their triumphant armies should enter into possession of Canaan. By this law, the leasing of three products was granted to the destitute inhabitants of the soil, the olive, the grape-vine, and corn: the olive was to be beaten but once; the scattered grape in the vintage was not to be gathered; and in the field where the corn grew, 'clean riddance' was not to be made, the corners were to be left unreaped, and even the forgotten sheaf was not to be fetched away by the owner, but to be left for the 'poor and the stranger, the fatherless and the widow.' This was not simply declared once, as an act of mercy, but enjoined and confirmed by ordinances thrice repeated, and impressed with particular solemnity: 'I am the Lord thy God, I have given thee all, and I command unreserved obedience to this my appointment.'"

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